Scilab Textbook Companion for Basic Electrical and Electronics Engineering-i by S. K. Bhattacharya and Debashis De[1]

Created by
Mohd Arif
B.Tech
Electronics Engineering
Uttarakhand Technical University
College Teacher
None
Cross-Checked by
Spandana

June 1, 2016

[1]Funded by a grant from the National Mission on Education through ICT, http://spoken-tutorial.org/NMEICT-Intro. This Textbook Companion and Scilab codes written in it can be downloaded from the "Textbook Companion Project" section at the website http://scilab.in

Book Description

Title: Basic Electrical and Electronics Engineering-i

Author: S. K. Bhattacharya and Debashis De

Publisher: Dorling Kindersley, India

Edition: 1

Year: 2011

ISBN: 978-81-317-5604-1

Scilab numbering policy used in this document and the relation to the above book.

Exa Example (Solved example)

Eqn Equation (Particular equation of the above book)

AP Appendix to Example(Scilab Code that is an Appednix to a particular Example of the above book)

For example, Exa 3.51 means solved example 3.51 of this book. Sec 2.3 means a scilab code whose theory is explained in Section 2.3 of the book.

Contents

List of Scilab Codes

Chapter 1

DC Networks and Network Theorems

Scilab code Exa 1.1 Convert Voltage source

```
//Example 1_1
clc;
clear;
close;
format('v',6);
//given data :
Vs=20;//V
Rse=5;//ohm(Internal Resistance)
//Source Conversion
Is=Vs/Rse;//A
Rsh=Rse;//ohm(same)
disp(Is,"Equivalent current source(A)");
disp(Rsh,"Internal resistance in parallel(ohm)")
```

Scilab code Exa 1.2 Conversion of a Voltage source

```
//Example 1_2
clc;
clear;
close;
format('v',6);
//given data :
Is=100;//A
Rsh=10;//ohm
//Source Conversion
Vs=Is*Rsh;//V
disp(Vs,"Equivalent voltage source(V)");
Rse=Rsh;//ohm
disp(Rse,"Internal resistance in series(ohm)");
```

Scilab code Exa 1.3 Calculate the current

```
//Example 1_3
clc;
clear;
close;
format('v',6);
//given data :
Vs=12;//V
Req=2+4*(2+2)/(4+(2+2));//ohm
I=Vs/Req;//A
I1=I;//A(Current in first 2 ohm resistance)
disp(I1,"Current in first 2 ohm resistance(A)");
I2=I/2;//A(Current in 4 ohm resistance)
disp(I2,"Current in 4 ohm resistance(A)");
I3=I/2;//A(Current in remaining 2 ohm resistances)
disp(I3,"Current in remaining 2 ohm resistances(A)");
```

Scilab code Exa 1.4 Calculate the current

```
//Example 1_4
clc;
clear;
close;
format('v',6);
//given data :
Vs=6;//V
//Point A & C, B & D are shorted
RAB=(4*4/(4+4));//ohm
RDC=(4*4/(4+4));//ohm
Req=RAB*RDC/(RAB+RDC);//ohm
Is=Vs/Req;//A
disp(Is,"Current supplied by the battery(A)");
```

Scilab code Exa 1.5 Calculate the current

```
//Example 1_5
clc;
clear;
close;
format('v',6);
//given data :
//Point B & C are shorted
RAB=(4*4/(4+4));//ohm
RBD=(4*4/(4+4));//ohm
Req=RAB+RBD;//ohm
disp(Req,"Equivalent Resistance(ohm)");
```

Scilab code Exa 1.6 Calculate the branch current

```
//Example 1_6
```

```
clc;
clear;
close;
format('v',6);
//given data :
format('v',6);
I=2;//A
//3*I1+8*I2=6 from loop ABCA
//7*I1-5*I2=0 from loop ADCA
A=[3 8;7 -5];//coefiicient matrix
B=[6;0];//coefiicient matrix
X=A^-1*B;//Matrix multiplication
I1=X(1);//A
I2=X(2);//A
I3=I-I1-I2;//A
disp(I3,"Current in branch AB & BC(A)");
disp(I1,"Current in branch AD & DC(A)");
disp(I2,"Current in branch AC(A)");
```

Scilab code Exa 1.7 Calculate the current

```
//Example 1_7
clc;
clear;
close;
format('v',5);
//given data :
//11*I2+8*I3=4 from loop GDAG
//8*I2+11*I3=6 from loop HDAH
A=[11 8;8 11];//coefiicient matrix
B=[4;6];//coefiicient matrix
X=A^-1*B;//Matrix multiplication
I2=X(1);//A
I3=X(2);//A
I8=I2+I3;//A
```

```
disp(I8,"Current in 8 ohm resistor(A)");
```

Scilab code Exa 1.8 Calculate the current

```
//Example 1_8
clc;
clear;
close;
format('v',6);
//given data :
//6*I1-3*I2=2 from mesh 1
//-6*I1+14*I2=4 from mesh 2
A=[6 -3;-6 14];//coefiicient matrix
B=[2;4];//coefiicient matrix
X=A^-1*B;//Matrix multiplication
I1=X(1);//A
I2=X(2);//A
disp(I1,"Current in 2ohm & 4ohm resistor(A)");
disp(I2,"Current in 3ohm & 5ohm resistor(A)");
I6ohm=I1-I2;//A(Current in 6ohm resistor)
disp(I6ohm,"Current in 6ohm resistor(A)");
```

Scilab code Exa 1.9 Determine unknown voltage

```
//Example 1_9
clc;
clear;
close;
format('v',6);
//given data :
//9*I1-2*I2-3*I3=24-V from mesh 1
//I1-6*I2+3*I3=0 from mesh 2
//3*I1+6*I2-11*I3=-V from mesh 3
```

```
d=[9 -2 -3;1 -6 3;3 6 -11];
delta=det(d);//determinant
//d1=[24-V -2 -3;0 -6 3;-V 6 -11];
//delta1=det(d1);determinant
//Putting I1=delta1/delta=0
V=(24*(66-18))/((66-18)+(-6-18));//V
disp(V,"Unknown Voltage(V)");
```

Scilab code Exa 1.10 Voltage at nodes

```
//Example 1_10
clc;
clear;
close;
format('v',5);
//given data :
VD=10;//V
VE=6;//V
R1=3;R2=4;R3=14;R4=8;R5=12;//ohm
//Ohm's current law
//I1=(VD-VB)/R1;I2=VB/R4;I3=(VK-VC)/R2;//A
//Where VK=VB-3;//V
//KCL at Node B  : 17*VB-6*VC=98
//KCL at Node C  : 21*VB-34*VC=27
A=[17 -6;21 -34];//Coefficient Matrix
B=[98;27];//Coefficient Matrix
X=A^-1*B;//solution
VB=X(1);//V
VC=X(2);//V
I2=VB/R4;//A
disp(I2,"Current through the 8 ohm resistor(A) : ");
```

Scilab code Exa 1.11 Value of current

```
//Example 1_11
clc;
clear;
close;
format('v',5);
//given data :
VA=24;//V
VC=12;//V
R1=6;R2=6;R3=6;//ohm
//Considering VA only, making VC short circuit
I=VA/(R1+R2*R3/(R2+R3));//A//from source VA
I1A=I*R2/(R1+R2);//A//through BD from VA only
//Considering VC only, making VA short circuit
I=VC/(R3+R1*R2/(R1+R2));//A//from source VC
I1C=I*R2/(R1+R2);//A//through BD from VA only
IBD=I1A+I1C;//A
disp(IBD,"Current IBD in the Circuit(A) : ");
```

Scilab code Exa 1.12 Calculate the current

```
//Example 1_12
clc;
clear;
close;
format('v',5);
//given data :
VA=75;//V
VB=64;//V
R1=5;R2=5;R3=4;R4=20;R5=12;//ohm
//Considering VA only, making VB short circuit
I=VA/(R1+(R3*R5/(R3+R5)+R2)*R4/(R4+R3*R5/(R3+R5)+R2)
   );//A//from source VA
I1A=I*R4/(R4+R2+R3*R5/(R3+R5));//A//through AB from
   VA only
//Considering VB only, making VA short circuit
```

```
I=VB/(R3+(R1*R4/(R1+R4)+R2)*R5/(R5+R1*R4/(R1+R4)+R2)
   );//A//from source VB
I1B=I*R5/(R5+(R1*R4/(R1+R4)+R2));//A//through AB
   from VB only
IAB=I1A-I1B;//A//total current through R2=5 ohm
disp(IAB,"Current I in the Circuit is equal to IAB(A
   ) : ");
```

Scilab code Exa 1.13 Calculate the current

```
//Example 1_13
clc;
clear;
close;
format('v',5);
//given data :
V=20;//V
I=2;//V
R1=2;R2=4;R3=8;//ohm
//Considering current source only, making Voltage
   source short circuit
I1=I*R1/(R1+R3);//A//through B to A
//Considering Voltage source only, making current
   source open circuit
I2=V/(R1+R3);//A//through A to B
IAB=I2-I1;//A//total current through R2=5 ohm
disp(IAB,"Current through 8ohm resistor(A) : ");
```

Scilab code Exa 1.14 Calculate the current

```
//Example 1_14
clc;
clear;
```

```
close;
format('v',5);
//given data :
V1=40;//V
V2=44;//V
R1=2;//ohm
R2=4;//ohm
R3=6;//ohm
I1=poly(0,'I1');
I2=poly(0,'I2');
//From Mesh ABEFA//eq1=V1-R1*I1+R2*I2-V2;
//-R1*I1+R2*I2=V2-V1;//eqn(1)
//From Mesh BCDED//eq2=-R2*I2-R3*(I1+I2)+V2;
//R3*I1+(R2+R3)*I2=V2;//eqn(2)
A=[-R1 R2;R3 (R2+R3)];//coefficient matrix
B=[V2-V1;V2];//coefficient matrix
X=A^-1*B;//
I1=X(1);//A
disp(I1,"Current I1(A)");
I2=X(2);//A
disp(I2,"Current I2(A)");
I=I1+I2;//A
disp(I,"Total Current I(A)");
```

Scilab code Exa 1.15 Calculate the current

```
//Example 1_15
clc;
clear;
close;
format('v',6);
//given data :
V=2;//V
R1=1;//ohm
R2=2;//ohm
```

```
R3=3;//ohm
R4=2;//ohm
R5=4;//ohm
//Mesh ABDA: -I1-R5*I3+R4*I2=0
//Mesh BCDB: -R2*(I1-I3)+R3*(I2+I3)+R5*I3=0
//Mesh ABCA: -I1-R2*(I1-I3)+V=0
A=[-R1 R4 -R5;-R2 R3 R3+R2+R5;-R3 0 R2];//
    coefficient matrix
B=[0;0;-V];//coefficient matrix
X=A^-1*B;//
I3=X(3);//A
disp(I3,"Current through galvanometer, I3(A)");
```

Scilab code Exa 1.16 Determine Current Is

```
//Example 1_16
clc;
clear;
close;
format('v',5);
//given data :
R1=4;//ohm
R2=6;//ohm
R3=8;//ohm
//I1=I2+IS//eqn(1)
//I2+I3=V1/4//eqn(2)
Vo=16;//V
//VAC+VAB=Vo : V1+R1*I2=Vo///eqn(3)
//I1=V1/R2;//eqn(4)
I3=Vo/R3;//A
//V1/4-I2=I3//eqn(5)
//solving eqn(3) & eqn(5)
A=[1 R1;1/4 -1];
B=[Vo;I3];
X=A^-1*B;
```

```
V1=X(1);//V
I2=X(2);//A
I1=V1/6;//A
Is=I1-I2;//A
disp(Is,"Current Is(A)");
```

Scilab code Exa 1.17 Determine Load Current

```
//Example 1_17
clc;
clear;
close;
format('v',5);
//given data :
V1=12;//V
V2=10;//V
R1=2;//ohm
R2=1;//ohm
R3=10;//ohm
//Node A : I1=(V1-VA)/2
//Node B : I2=(V2-VB)/2
//IL=VB/R3;//A
//IL=I1+I2
VA=10;VB=10//V
I1=(V1-VA)/2;//A//from Node A
I2=(V2-VB)/2;//A//from Node B
IL=VB/R3;//A
disp(I1,"Current by Battery A, IA(A)");
disp(I2,"Current by Battery B, IA(A)");
disp(IL,"Load Current(A)");
```

Scilab code Exa 1.18 Voltage at nodes

```
//Example 1_18
clc;
clear;
close;
format('v',8);
//given data :
V1=10;//V
V2=3;//V
V3=6;//V
R1=3;//ohm
R2=4;//ohm
R3=14;//ohm
R4=8;//ohm
R5=12;//ohm
//Node B : (V1-VB)/R1=VB/R4+(VB-VC-V2)/R2
//VB(1/R4+1/R1+1/R2)+VC*(-1/R2)=V2/R2+V1/R1//eq(1)
A1=[(1/R4+1/R1+1/R2) (-1/R2)];//Coefficient Matrix
B1=[V2/R2+V1/R1];//Coefficient Matrix
//Node C: VC/R5=(VB-VC-V2)/R2+(V3-VC)/R3
//VB*(-1/R2)+VC(1/R2+1/R5+1/R3)=V3/R3-V2/R2//eq(2)
A2=[(-1/R2) (1/R2+1/R5+1/R3)]////Coefficient Matrix
B2=[V3/R3-V2/R2];////Coefficient Matrix
A=[A1;A2];B=[B1;B2];//Coefficient Matrix
X=A^-1*B;//solution of matrix
VB=X(1);//V
VC=X(2);//V
I2=VB/R4;//A
disp(I2,"Current through 8 ohm resistor(A)");
```

Scilab code Exa 1.19 Calculate the current

```
//Example 1_19
clc;
clear;
close;
```

```
format('v',5);
//given data :
E1=2.05;//V
E2=2.15;//V
V3=6;//V
R1=0.05;//ohm
R2=0.04;//ohm
R3=1;//ohm
//Considering E1 only, Make E2 short circuit
I1=E1/(R1+R2*R3/(R2+R3));//A
disp(I1,"Current supplied by battery1(A)");
I1dash=I1*R2/(R2+R3);//A
format('v',6);
//Considering E2 only, Make E1 short circuit
I2=E2/(R2+R1*R3/(R1+R3));//A
disp(I2,"Current supplied by battery2(A)");
I2dash=I2*R1/(R1+R3);//A
I=I1dash+I2dash;//A
disp(I,"Current through 1ohm resistance, Load
    current(A)");
```

Scilab code Exa 1.20 Determine Current

```
//Example 1_20
clc;
clear;
close;
format('v',5);
//given data :
V=20;//V
I=2;//A
V3=6;//V
R1=2;//ohm
R2=4;//ohm
R3=8;//ohm
```

```
//Considering current source only, Make Voltage
    source short circuit
I1dash=I*R1/(R1+R3);//A
//Considering Voltage source only, Make Current
    source opent circuit
I1dash2=V/(R1+R3);//A
I=I1dash2-I1dash;//A
disp(I,"Current through 8 ohm resistor from A to B(A
    )");
```

Scilab code Exa 1.21 Range of current

```
//Example 1_21
clc;
clear;
close;
format('v',5);
//given data :
V1=90;//V
V2=50;//V
V3=100;//V
R1=60;//ohm
R2=40;//ohm
R3=30;//ohm
R4=60;//ohm
R=6:36;//ohm
//Open circuit AB
I1=V1/(R1+R3);//A
I2=V3/(R2+R4);//A
//Potential of point A
VA=I1*R3+V2;//V
//Potential of point B
VB=I2*R4;//V
VOC=VA-VB;//V
Req=R1*R3/(R1+R3)+R2*R4/(R2+R4);//ohm
```

```
Imin=VOC/(Req+max(R));//A
Imax=VOC/(Req+min(R));//A
disp("The current through resistor R will vary from
   "+string(Imin)+" A to "+string(Imax)+" A.");
```

Scilab code Exa 1.22 Calculate the current

```
//Example 1_22
clc;
clear;
close;
format('v',6);
//given data :
V1=24;//V
V2=12;//V
R1=4;//ohm
R2=5;//ohm
R3=3;//ohm
R4=5;//ohm
R5=3;//ohm
RL=10;//ohm
//Open circuit AB
I=V1/(R1+R2+R3);//A
//Potential of point A
VBQ=0;//V//there is no current
VPS=0;//V//there is no current
VQP=I*(R2+R3);//V
VSA=V2;//V
//Potential of point A with respect to B
VAB=VBQ+VQP+VPS-VSA;//V
VOC=VAB;//V
Req=R1*(R2+R3)/(R1+R2+R3)+R4+R5;//ohm
//Thevenin equivalent current
I=VOC/(Req+RL);//A
disp(I,"Current flowing through load resistance(A)")
```

;

Scilab code Exa 1.23 Calculate the current

```
//Example 1_23
clc;
clear;
close;
format('v',6);
//given data :
V1=12;//V
I=2;//A
R1=2;//ohm
R2=4;//ohm
R3=3;//ohm
R4=3;//ohm
R5=5;//ohm
//Converting current source into Voltage source
V2=I*R3;//V//Converted source
//writing KVL equation for the loop
I1=poly(0,'I1');
eqn=-R1*I1+V1-R2*I1-R3*I1-V2;//KVL equation
I1=roots(eqn);//A
VSR=V2+R3*I1;//V
VRA=0;//V//there is no current
//Potential of point A with respect to B
VAB=VSR+VRA;//V
VOC=VAB;//V
Req=(R1+R2)*R3/(R1+R2+R3)+R4;//ohm
//Thevenin equivalent current
I=VOC/(Req+R5);//A
disp(I,"Current flowing through 5 ohm Resistance(A)"
    );
```

Scilab code Exa 1.24 Determine Current

```
//Example 1_24
clc;
clear;
close;
format('v',6);
//given data :
V1=6;//V
V2=15;//V
R1=6;//ohm
R2=3;//ohm
R3=4;//ohm
R4=6;//ohm
//writing KVL equation for the loop
I=poly(0,'I');
eqn=V2-R2*I-R1*I-V1;//KVL equation
I=roots(eqn);//A
VCD=V2-R2*I;//V
//Potential of point A with respect to B
VAB=VCD;//V
VOC=VAB;//V
Req=R1*R2/(R1+R2)+R3;//ohm
//Thevenin equivalent current
I=VOC/(Req+R4);//A
disp(I,"Current flowing through terminal AB(A)");
```

Scilab code Exa 1.25 Calculate the current

```
//Example 1_25
clc;
clear;
```

```
close;
format('v',6);
//given data :
V1=2;//V
R1=10;//ohm
R2=20;//ohm
R3=40;//ohm
R4=30;//ohm
R5=15;//ohm
//solution
VBC=R4/(R4+R1)*V1;//V
VDC=R5/(R2+R5)*V1;//V
VBD=VBC-VDC;//V
Vth=VBD;//V
Req=R1*R4/(R1+R4)+R2*R5/(R2+R5);//ohm
//Thevenin equivalent current
IL=Vth/(Req+R3);//A
IL=IL*1000;//mA
disp(IL,"Current through BD, from B to D(mA)");
```

Scilab code Exa 1.26 Calculate the branch current

```
//Example 1_26
clc;
clear;
close;
format('v',5);
//given data :
E1=140;//V
R1=30;//ohm
R2=70;//ohm
E2=85;//V
RL=[5 15 50];//ohm
//solution
//writing KVL equation for the loop
```

```
I=poly(0,'I');
eqn=E1-R1*I-R2*I-E2;//KVL equation
I=roots(eqn);//A
Vth=E1-I*R1;//V
Req=R1*R2/(R1+R2);//ohm
//Thevenin equivalent current
IL1=Vth/(Req+RL(1));//A//for RL=5 ohm
IL2=Vth/(Req+RL(2));//A//for RL=15 ohm
IL3=Vth/(Req+RL(3));//A//for RL=50 ohm
disp(IL1,"RL=5 ohm, branch current I2(A)");
disp(IL2,"RL=15 ohm, branch current I2(A)");
disp(IL3,"RL=50 ohm, branch current I2(A)");
```

Scilab code Exa 1.27 Calculate the current

```
//Example 1_27
clc;
clear;
close;
format('v',4);
//given data :
V1=20;//V
V2=4;//V
R1=500;//ohm
R2=1000;//ohm
R3=100;//ohm
R4=800;//ohm
RL=1000;//ohm
//solution
VCB=-R2/(R4+R2)*V1;//V
//writing KVL equation for the loop
I=poly(0,'I');
eqn=V1-R1*I-V2-R3*I;//KVL equation
I=roots(eqn);//A
VCA=-I*R1;//V
```

```
//Potential at point B with respect to A
VBA=VCB-VCA;//V
VOC=VBA;//V
Vth=VOC;//V
Req=R1*R3/(R1+R3)+R2*R4/(R2+R4);//ohm
//Thevenin equivalent current
IL=Vth/(Req+RL);//A
IL=IL*1000;//mA
disp(IL,"Current through 1000 ohm resistor(mA)");
```

Scilab code Exa 1.28 Calculate the current

```
//Example 1_28
clc;
clear;
close;
format('v',5);
//given data :
V1=15;//V
V2=4;//V
R1=4;//ohm
R2=3;//ohm
R3=2;//ohm
R4=5;//ohm
I1=6;//A
RL=R4;//ohm
//solution
Req=R1*R3/(R1+R3)+R2;//ohm
//Converting current source into Voltage source
V2=I1*R3;//V//Converted source
//writing KVL equation for the loop
I=poly(0,'I');
eqn=V1-R1*I-R3*I-V2;//KVL equation
I=roots(eqn);//A
//Potential at point A with respect to B
```

```
VAB=V2+R3*I;//V
//Thevenin equivalent current
I=VAB/(Req+RL);//A
disp(I,"Current through 5 ohm resistor(A)");
```

Scilab code Exa 1.29 Calculate the current

```
//Example 1_29
clc;
clear;
close;
format('v',5);
//given data :
V1=12;//V
V2=24;//V
R1=4;//ohm
R2=4;//ohm
R3=4;//ohm
RL=5;//ohm
//solution by Norton Theorem
//Short Circuit AB
I=V1/(R1*R3/(R1+R3));//A
ISC1=I*R3/(R1+R3);//A
ISC2=V2/R3;//A
ISC=ISC1+ISC2;//A
Req=R1*R3/(R1+R3);//ohm
//Norton equivalent current
IL=ISC*Req/(Req+RL);//A
disp(IL,"By Nortons theorem, Current through load
    resistance(A)");
//solution by Thevenin Theorem
Rth=Req;//ohm
//Loop PQRS, Applying KVL
//V1-I1*R1-I2*R1=0
A1=[-R1 -R1];//Coefficient Matrix
```

```
B1=[-V1];//Coefficient Matrix
//Loop NTRS, Applying KVL
//V2-I2*R3-R2*I2-R1*I1-R1*I2=0
A2=[-R3-R2-R1 -R1];//Coefficient Matrix
B2=[-V2];//Coefficient Matrix
A=[A1;A2];//Coefficient Matrix
B=[B1;B2];//Coefficient Matrix
X=A^-1*B;//soolution matrix
I1=X(1);//A
I2=X(2);//A
VOC=V2-R3*I2;//A
IL=VOC/(Rth+RL);//A
disp(IL,"By Thevenins theorem, Current through load
   resistance(A)");
```

Scilab code Exa 1.30 Determine Current

```
//Example 1_30
clc;
clear;
close;
format('v',5);
//given data :
I1=10;//A
V2=12;//V
R1=2;//ohm
R2=2;//ohm
R3=6;//ohm
R4=6;//ohm
//solution by Norton Theorem
RL=R4;//ohm
//Short Circuit AB
ISC1=I1*R1/(R1+R2);//A//by current source
ISC2=V2/R3;//A///by voltage source
ISC=ISC1+ISC2;//A
```

```
Req=(R1+R2)*R3/(R1+R2+R3);//ohm
//Norton equivalent current
I=ISC*Req/(Req+RL);//A
disp(I,"By Nortons theorem, Current through 6 ohm
    resistance connected across AB(A)");
//solution by Thevenin Theorem
Rth=Req;//ohm
//Converting current source into Voltage source
V1=I1*R1;//V//Converted source
//Applying KVL
I=poly(0,'I');//A
eqn=V1-R1*I-R2*I-R3*I-V2;//
I=roots(eqn);//A
VOC=V2+R3*I;//A
I=VOC/(Rth+RL);//A
disp(I,"By Thevenins theorem, Current through 6 ohm
    resistance connected across AB(A)");
//Unit of current is given wrong in the book.
```

Scilab code Exa 1.31 Norton and Thevenin theorem

```
//Example 1_31
clc;
clear;
close;
format('v',5);
//given data :
V1=12;//V
V2=6;//V
V3=24;//V
R1=4;//ohm
R2=2;//ohm
R3=6;//ohm
R4=3;//ohm
R5=12;//ohm
```

```
R6=16; //ohm
//solution by Norton Theorem
RL=R6; //ohm
//Thevenin theorem
//Loop 1 applying KVL
//V1-(R1+R2)*I1+V2-R3*(I1+I2);
A1=[-R1-R2-R3 -R3]; //Coefficient Matrix
B1=[-V1-V2]; //Coefficient Matrix
//Loop 2 applying KVL
//V3-R4*I2+V2-R3*(I1+I2)-R5*I2;
A2=[-R3 -R4-R3-R5]; //Coefficient Matrix
B2=[-V3-V2]; //Coefficient Matrix
A=[A1;A2]; //Coefficient Matrix
B=[B1;B2]; //Coefficient Matrix
X=A^-1*B; //soolution matrix
I1=X(1); //A
I2=X(2); //A
VOC=-R5*I2+V3; //V
Rth=((R1+R2)*R3/(R1+R2+R3)+R4)*R5/((R1+R2)*R3/(R1+R2
    +R3)+R4+R5); //ohm
I=VOC/(Rth+RL); //A
disp(I,"By Thevenin Theorem, current through 16 ohm
    resistor(A)");
//solution by Norton Theorem
//Converting Voltage sources into current sources
I1=V1/(R1+R2); //A
I2=V2/R3; //A
I3=V3/R5; //A
Req=Rth; //ohm
//Combining I1 & I2 | parallel & opposite
I1=I1-I2; //A
I2=0; //A
ISC1=I1/2; //A//considering I1 only
ISC2=I3; //A//considering I3 only
ISC=ISC1+ISC2; //A
//Norton equivalent current
I=ISC*Req/(Req+RL); //A
disp(I,"By Nortons theorem, current through 16 ohm
```

```
resistor(A)");
```

Scilab code Exa 1.32 Value of maximum power

```
//Example 1_32
clc;
clear;
close;
format('v',5);
//given data :
V=12;//V
R1=2;//ohm
R2=2;//ohm
R3=2;//ohm
R4=2;//ohm
R5=2;//ohm
//calculating Open circuit voltage :
I=V/(R1+R2+R3);//V
VCD=I*R3;//V
VAB=VCD;//V//Open circuit voltage
Req=(R1+R2)*R3/(R1+R2+R3)+R4+R5;//ohm
RL=Req;//ohm//For maximum Power transfer
disp(RL,"For maximum Power transfer, RL(ohm)");
PLmax=VAB^2/4/RL;//W
disp(PLmax,"Value of maximum Power(W)");
```

Scilab code Exa 1.33 Value of load resistance

```
//Example 1_33
clc;
clear;
close;
format('v',5);
```

```
//given data :
V1=12;//V
R1=3;//ohm
R2=3;//ohm
I2=6;//A
//Converting currrent sources into Voltage sources
V2=I2*R2;//V
//writing KVL equation for the loop
I=poly(0,'I');
eqn=V1-R1*I-R2*I-V2;//KVL equation
I=roots(eqn);//A
VOC=V2+R2*I;//V
Req=R1*R2/(R1+R2);//ohm
RL=Req;//ohm//For maximum Power transfer
disp(RL,"For maximum Power transfer, RL(ohm)");
I=VOC/(Req+RL);//A
PLmax=I^2*RL;//W
disp(PLmax,"Value of maximum Power(W)");
Ri=Req;//ohm
Eta=1/(1+Ri/RL)*100;//%
disp(Eta,"Power Transfer Efficiency(%)");
```

Scilab code Exa 1.34 Value of load resistance

```
//Example 1_34
clc;
clear;
close;
format('v',5);
//given data :
V1=48;//V
R1=4;//ohm
R2=20;//ohm
R3=12;//ohm
R4=12;//ohm
```

```
V2=12;//V
//Open circuit AB
I1=V1/(R1+R2);//A
I2=V1/(R3+R4);//A
VR1=V1*R1/(R1+R2);//V//across 4 ohm resistance
VR2=V1*R2/(R1+R2);//V//across 20 ohm resistance
VR3=V1*R3/(R3+R4);//V//across 12 ohm resistance
VCE=VR2;//V
VCD=VR3;//V
VBC=V2+VR3;//V
//POtential of A wih respect to B
VOC=VCE-VBC;//V
Rth=R1*R2/(R1+R2)+R3*R4/(R3+R4);//ohm
Ri=Rth;//ohm
RL=Ri;//ohm//For maximum Power transfer
disp(RL,"For maximum Power transfer, RL(ohm)");
I=VOC/(Rth+RL);//A
PL=I^2*RL;//W
disp(PL,"Value of maximum Power(W)");
//Answer in the textbook is wrong.
```

Scilab code Exa 1.35 Value of load resistance

```
//Example 1_35
clc;
clear;
close;
format('v',5);
//given data :
V=12;//V
R1=4;//ohm
R2=6;//ohm
R3=6;//ohm
R4=6;//ohm
//Current by the source while -AB open circuit
```

```
I=V/(R2*R3*R4/(R2*R3+R3*R4+R2*R4)+R1);//A
//Voltage across AB
VOC=I*(R2*R3*R4/(R2*R3+R3*R4+R2*R4));//V\
//Thevenin equivalent Resistance
Rth=(R2*R3*R4/(R2*R3+R3*R4+R2*R4)*R1/(R2*R3*R4/(R2*R3+R3*R4+R2*R4)+R1));//ohm
Ri=Rth;//ohm
RL=Ri;//ohm//For maximum Power transfer
disp(RL,"For maximum Power transfer , RL(ohm)");
I=VOC/(Rth+RL);//A
PL=I^2*RL;//W
disp(PL,"Value of maximum Power(W)");
Eta=RL/(RL+Ri)*100;//%
disp(Eta,"Power Transfer Efficiency(%)");
```

Scilab code Exa 1.36 Calculate equivalent resistance

```
//Example 1_36
clc;
clear;
close;
format('v',5);
//given data :
R1=3;//ohm
R2=6;//ohm
R3=3;//ohm
R4=3;//ohm
R5=6;//ohm
R6=3;//ohm
R25=R2*R5/(R2+R5);//ohm
RBC=R25;//ohm
RAB=R4;//ohm
RAC=R6;//ohm
RA=RAB*RAC/(RAB+RAC+RBC);//ohm
RB=RAB*RBC/(RAB+RAC+RBC);//ohm
```

```
RC=RAC*RBC/(RAB+RAC+RBC);//ohm
RPQ=(R1+RB)*(R3+RA)/(R1+RB+R3+RA)+RC;//ohm
disp(RPQ,"Equivalent Resistance across P & Q(ohm)");
```

Scilab code Exa 1.37 Calculate the current

```
//Example 1_37
clc;
clear;
close;
format('v',5);
//given data :
V=12;//V
RAB=3;//ohm
RAC=3;//ohm
RBC=3;//ohm
RBD=3;//ohm
RCD=3;//ohm
RA=RAB*RAC/(RAB+RAC+RBC);//ohm
RB=RAB*RBC/(RAB+RAC+RBC);//ohm
RC=RAC*RBC/(RAB+RAC+RBC);//ohm
Req=RA+(RB+RBD)*(RC+RCD)/(RB+RBD+RC+RCD);//ohm
I=V/Req;//A
disp(I,"Current I supplied by the battery(A)");
```

Scilab code Exa 1.40 Find the voltage drop

```
//Example 1_40
clc;
clear;
close;
format('v',5);
//given data :
```

```
V=24;//V
R1=7;//ohm
R2=7;//ohm
R3=7;//ohm
R4=7;//ohm
R5=8;//ohm
R6=10;//ohm
RAB=(R5*R6/(R5+R6)+R4)*(R2+R3)/(R5*R6/(R5+R6)+R4+R2+
    R3)+R1;//ohm
I=V/RAB;//A
I2=I*(R2+R3)/(R2+R3+R5*R6/(R5+R6)+R4);//A
VPQ=I2*(R5*R6/(R5+R6));//V
disp(VPQ,"Voltage drop across the 10 ohm resistor(V)
    ");
//Answer in the book is not accurate.
```

Scilab code Exa 1.41 Calculate equivalent resistance

```
//Example 1_41
clc;
clear;
close;
format('v',5);
//given data :
R1=5;//ohm
R2=5;//ohm
R3=10;//ohm
R4=10;//ohm
RAB=(R1+R3)*(R2+R4)/(R1+R3+R2+R4);//ohm
disp(RAB,"Equivalent resistance(ohm)");
```

Scilab code Exa 1.42 Calculate the total current

```
//Example 1_42
clc;
clear;
close;
format('v',4);
//given data :
V=24;//V
R1=2;//ohm
R2=3;//ohm
R3=5;//ohm
R4=8;//ohm
R5=2;//ohm
R6=5;//ohm
R7=3;//ohm
R8=6;//ohm
R57=R5+R7;//ohm//in series
RAB=R3;//ohm
RAC=R57;//ohm
RBC=R6;//ohm
RA=RAB*RAC/(RAB+RAC+RBC);//ohm
RB=RAB*RBC/(RAB+RAC+RBC);//ohm
RC=RAC*RBC/(RAB+RAC+RBC);//ohm
Req=R1+RA+(RC+R8)*(RB+R4)/(RC+R8+RB+R4)+R2;//ohm
I=V/Req;//A
disp(I,"Total current by the battery(A)");
```

Scilab code Exa 1.43 Required Voltage

```
//Example 1_43
clc;
clear;
close;
format('v',6);
//given data :
VAP=25;//V
```

```
RAP=15;//ohm
RAQ=5;//ohm
R3=5;//ohm
RBP=10;//ohm
RBQ=20;//ohm
RAB=RAP*RAQ/(RAP+RAQ)+RBP*RBQ/(RBP+RBQ);//ohm
disp(RAB,"Equivalent resistance across terminal AB(ohm)");
I=VAP/(RAP*RAQ/(RAP+RAQ));//A
VBQ=(RBP*RBQ/(RBP+RBQ))*I;//V
V=VAP+VBQ;///V
disp(V,"Required Voltage(V)");
```

Scilab code Exa 1.45 Find the resistance

```
//Example 1_45
clc;
clear;
close;
format('v',5);
//given data :
RAB=4;//ohm
RAC=6;//ohm
RBC=2;//ohm
RBD=10;//ohm
RCD=14;//ohm
RA=RAB*RAC/(RAB+RAC+RBC);//ohm
RB=RAB*RBC/(RAB+RAC+RBC);//ohm
RC=RAC*RBC/(RAB+RAC+RBC);//ohm
Req=RA+(RB+RBD)*(RC+RCD)/(RB+RBD+RC+RCD);//ohm
disp(Req,"Total Resistance(ohm)");
```

Scilab code Exa 1.46 Find the resistance

```
//Example 1_46
clc;
clear;
close;
format('v',5);
//given data :
RAD=20;//ohm
RAC=30;//ohm
RDC=50;//ohm
RDB=50;//ohm
RBC=45;//ohm
RAN=RAD*RAC/(RAD+RAC+RDC);//ohm
RDN=RAD*RDC/(RAD+RAC+RDC);//ohm
RCN=RAC*RDC/(RAD+RAC+RDC);//ohm
RAB=RAN+(RDN+RDB)*(RCN+RBC)/(RDN+RDB+RCN+RBC);//ohm
disp(RAB,"Total Resistance between terminal A & B(
    ohm)");
```

Scilab code Exa 1.47 Calculate the current

```
//Example 1_47
clc;
clear;
close;
format('v',5);
//given data :
V1=6;//V
V2=5;//V
V3=8;//V
R1=2;//ohm
R2=2;//ohm
R3=5;//ohm
R4=4;//ohm
//Node A :
VA=poly(0,'VA');
```

```
I1=(V1-VA)/R1;//A
I2=(V2-VA)/R2;//A
I3=(V3+VA)/R3;//A
//KCL at Node A
eqn=I1+I2-I3;
VA=roots(eqn);//V
VB=-V3;//V
I3=(VA-VB)/R3;//A
disp(I3,"Current flowing through 5 ohm Resistance(A)");
```

Scilab code Exa 1.48 Calculate the current

```
//Example 1_48
clc;
clear;
close;
format('v',5);
//given data :
V1=12;//V
V2=3;//V
V3=6;//V
R1=2;//ohm
R2=8;//ohm
R3=4;//ohm
R4=10;//ohm
R5=12;//ohm
//Node A//I1=I2+I3
VA=poly(0,'VA');
VB=poly(0,'VB');
I1=(V1-VA)/R1;//A
VK=VA-V2;//V
//I2=(VK-VB)/R3;//A
I3=VA/R2;//A
//7*VA-2*VB=56//eqn(1)
```

```
A1=[7 -2];//Coefficient Matrix
B1=[56];//Coefficient Matrix
//Node B //I2+I5=I4
I5=(V3-VB)/R5;//A
I4=VB/R4;//A
//15*VA-26*VB=15//eqn(2)
A2=[15 -26];//Coefficient Matrix
B2=[15];//Coefficient Matrix
A=[A1;A2];//Coefficient Matrix
B=[B1;B2];//Coefficient Matrix
X=A^-1*B;//solution Matrix
VA=X(1);//V
VB=X(2);//V
I3=VA/R2;//A
disp(I3,"Current through 8 ohm resistor(A)");
```

Scilab code Exa 1.49 Current in various branches

```
//Example 1_49
clc;
clear;
close;
format('v',5);
//given data :
I1=1;//A
V3=12;//V
I4=0.5;//A
R1=10;//ohm
R2=10;//ohm
R3=20;//ohm
R4=20;//ohm
R5=20;//ohm
//Node B//I1=I2+I3
VB=poly(0,'VB');
VC=poly(0,'VC');
```

```
VD=poly(0,'VD');
I2=(VB)/R1;//A
//I3=(VB-VC)/R1;//A
//2*VB-VC=10//eqn(1)
A1=[2 -1 0];//Coefficient Matrix
B1=[10];//Coefficient Matrix
//Node C //I3=I4+I5
I4=(VC-V3)/R3;//A
//I5=(VC-VD)/R4;//A
//2*VB-4*VC+VD=-12//eqn(2)
A2=[2 -4 1];//Coefficient Matrix
B2=[-12];//Coefficient Matrix
//Node D //I6=I5+I7
I6=VD/R5;//A
I7=I4;//A
//VC-2*VD=-10//eqn(3)
A3=[0 1 -2];//Coefficient Matrix
B3=[-10];//Coefficient Matrix
A=[A1;A2;A3];//Coefficient Matrix
B=[B1;B2;B3];//Coefficient Matrix
X=A^-1*B;//solution Matrix
VB=X(1);//V
VC=X(2);//V
VD=X(3);//V
I2=(VB)/R1;//A
I3=(VB-VC)/R1;//A
I5=(VC-VD)/R4;//A
I4=(-I3-I5);//A
I6=VD/R5;//A
disp("Current in various branches are : ");
disp(I2,"Current I2(A)");
disp(I3,"Current I3(A)");
disp(I4,"Current I4(A)");
disp(I5,"Current I5(A)");
disp(I6,"Current I6(A)");
```

Scilab code Exa 1.50 Calculate the current

```
//Example 1_50
clc;
clear;
close;
format('v',5);
//given data :
I=8;//A
I4=6;//A
R1=3;//ohm
R2=2;//ohm
R3=4;//ohm
//Applying KCL//I=I1+I2
//I=V1/R1+V1/R2-V2/R2//eqn(1)
A1=[1/R1+1/R2 -1/R2];//Coefficient Matrix
B1=[I];//Coefficient Matrix
//Applying KCL//I2=I3+I4
//V1/R2-V2/R2-V2/R3=I4//eqn(2)
A2=[1/R2 -1/R2-1/R3];//Coefficient Matrix
B2=[I4];//Coefficient Matrix
A=[A1;A2];//Coefficient Matrix
B=[B1;B2];//Coefficient Matrix
X=A^-1*B;//solution Matrix
V1=X(1);//V
V2=X(2);//V
I1=V1/R1;//A
I2=V1/R2-V2/R2;//A
I3=(V2)/R3;//A
disp("Current in various branches are : ");
disp(I1,"Current I1(A)");
disp(I2,"Current I2(A)");
disp(I3,"Current I3(A)");
```

Chapter 2

Electromagnetism

Scilab code Exa 2.1 Inductance and coupling coefficient

```
//Ex_2_1
clc;
clear;
close;
format('v',6);
//given data :
LTsc=1.6;//H(Series cumulative)
LTd=0.4;//H(differentially)
L1=0.6;//H
M=(LTsc-LTd)/4;//H(Mutual Inductance)
L2=LTsc-2*M-L1;//H
K=M/sqrt(L1*L2);//Coupling Coefficient
disp(M,"Mutual Inductance(H)");
disp(K,"Coupling Coefficient");
```

Scilab code Exa 2.2 Calculate the emf induced

```
//Ex_2_2
```

```
clc;
clear;
close;
format('v',6);
//given data :
l=0.5;//m
B=0.5;//Wb/m^2
I=50;//A
v=20;//m/s
F=B*l*I;//N
disp(F,"Force expereinced by the conductor(N)");
e=B*l*v;//V
disp(e,"emf induced(V)");
```

Scilab code Exa 2.3 Calculate Inductance and emf

```
//Ex_2_3
clc;
clear;
close;
format('v',6);
//given data :
N=100;//turns
l=0.5;//m
A=10/10000;//m^2
mur=2000;//relative permeability of iron
mu0=4*%pi*10^-7;//permeability
I=5;//A
t=10;//ms
L=mur*mu0*N^2*A/l*1000;//mH
disp(L,"Inductance of the coil(mH)");
E=L*2*I/t;//V
disp(E,"Induced emf in the coil(V)");
```

Scilab code Exa 2.4 Calculate Inductance and emf

```
//Ex_2_4
clc;
clear;
close;
format('v',6);
//given data :
N1=500;//turns
N2=2000;//turns
K=50/100;//coefficient for 50% flux linked
diBYdt=10;//A/s
L1=200;//mH
fi1BYI1=L1/N1;
M=N2*fi1BYI1;//mH
e2=M*10^-3*diBYdt;//V
disp(M/1000,"Mutual Inductance of two coil(H)");
disp(e2,"Induced emf in the coil having 1000 turns(V
    )");
```

Scilab code Exa 2.5 Mutual and Self Inductance

```
//Ex_2_5
clc;
clear;
close;
format('v',6);
//given data :
I1=5;//A
N1=500;//turns
fi1=1;//mWb
dt=10;//ms
```

```
e2=50;//V
K=60/100;//coefficient of coupling
di1=2*(I1);//A(as current changes from +5A to -5A)
M=e2*dt*10^-3/di1;//H
L1=N1*fi1/1000/I1;//H
L2=L1*M^2/K^2;//H
disp(M,"Mutual Inductance of two coil(H)");
disp(L1,"Self inductance of coil 1(H)");
disp(L2,"Self inductance of coil 2(H)");
//Answer is wrong in the book.
```

Scilab code Exa 2.6 Determine L1 L2 M and K

```
//Ex_2_6
clc;
clear;
close;
format('v',6);
//given data :
N1=1000;//turns
N2=400;//turns
K1=75/100;//coefficient of coupling
I1=6;//A
I2=6;//A
fi1=0.8;//mWb
fi2=0.5;//mWb
L1=N1*fi1*10^-3/I1;//H
L2=N2*fi2*10^-3/I2;//H
M=N2*K1*fi1*10^-3/I1;//H
K=M/sqrt(L1*L2);
disp(L1,"Self inductance of coil 1(H)");
disp(L2,"Self inductance of coil 2(H)");
disp(M,"Mutual Inductance of two coil(H)");
disp(K,"Coefficient of coupling");
```

Scilab code Exa 2.7 Calculate flux density

```
//Ex_2_7
clc;
clear;
close;
format('v',7);
//given data :
r=10;//cm
I=100;//A
d=5;//cm
mu0=4*%pi*10^-7;//permeability
Bc=mu0*I/2/(r/100);//Wb/m^2 or T
B=mu0*I*(r/100)^2/(2*((r/100)^2+(d/100)^2)^(3/2));//
    Wb/m^2
disp(Bc,"Flux density at the centre(Wb/m^2)");
disp(B,"Flux density in the plane(Wb/m^2)");
//Answer is wrong in the book.
```

Scilab code Exa 2.8 MMF and current

```
//Ex_2_8
clc;
clear;
close;
format('v',6);
//given data :
D=0.5;//m(mean diameter)
A=0.01;//m^2
fi=10/1000;//Wb
N=100;//turns
mmf1=10;//A-turn//(for Ni alloy)
```

```
mmf2=50;//A-turn//(for Si-steel alloy)
l=%pi*D;//m(total length)
lni=l/2;//m(length of Ni alloy)
lsi=l/2;//m(length of Si-steel)
mmf=mmf1*lni+mmf2*lsi;//A-turn///total mmf
disp(mmf,"mmf required(A-turn)");
I=mmf/N;//A
disp(I,"Current(A)");
```

Scilab code Exa 2.9 Calculate the reluctance

```
//Ex_2_9
clc;
clear;
close;
format('e',9);
//given data :
l=20/100;//m
A=1.5/10000;//m^2
mur=2000;//relative permeability
mu0=4*%pi*10^-7;//permeability
S=l/(mu0*mur*A);//AT/Wb
disp(S,"Reluctance of silicon steel(AT/Wb)");
```

Scilab code Exa 2.10 Calculate the amount of flux

```
//Ex_2_10
clc;
clear;
format('v',6);
close;
//given data :
D=25/100;//m
```

```
A=9/10000;//m^2
N=100;//turns
I=1.5;//A
l=%pi*D;//m
mur=2000;//relative permeability
mu0=4*%pi*10^-7;//permeability
fi=N*I/l*(mu0*mur*A);//Wb
disp(fi*1000,"Flux produced(mWb)");
```

Scilab code Exa 2.11 Calculate the current

```
//Ex_2_11
clc;
clear;
close;
format('v',6);
//given data :
lg=0.01/100;//m(airgap)
li=39.99/100;//m(mean length)
mur=2000;//relative permeability
mu0=4*%pi*10^-7;//permeability
N=1000;//turns
A=9/10000;//m^2
fi=1;//mWb
S=li/(mu0*mur*A)+lg/(mu0*A);//AT/Wb
I=fi*10^-3*S/N;//A
disp(I,"Current required(A)");
```

Scilab code Exa 2.12 Calculate the current

```
//Ex_2_12
clc;
clear;
```

```
close;
format('v',7);
//given data :
Ac=10/10000;//m^2
Ao=5/10000;//m^2(outer limbs)
Lo=25;//cm(outer limbs)
Lc=16;//cm
N=1000;//turns
fic=1.2;//mWb
fio=1.2;//mWb
B=1.2;//Wb/m^2
mmf=750;//AT/m
Bc=fic*10^-3/Ac;//Wb/m^2
Bo=fio*10^-3/Ao;//Wb/m^2
mmf_total=mmf*Lo/100+mmf*Lc/100;//AT/m
I=mmf_total/N;//A
disp(I,"Current required(A)");
```

Scilab code Exa 2.13 Calculate the amount of flux

```
//Ex_2_13
clc;
clear;
close;
format('v',4);
//given data :
Ao=5/10000;//m^2(outer limbs)
li=100/100;//m(iron path)
A=10/10000;//m^2
lg=1/1000;//m(airgap)
I1=3;//A
I2=2;//A
N1=100;//turns
N2=50;//turns
mur=2000;//relative permeability
```

```
mu0=4*%pi*10^-7;//permeability
mmf=N1*I1-N2*I2;//AT
S=1/(mu0*A)*[li/mur+lg];//AT/Wb
fi=mmf/S*1000;//mWb
disp(fi,"Flux available(mWb)");
```

Scilab code Exa 2.14 Calculate the amount of flux

```
//Ex_2_14
clc;
clear;
close;
format('v',10);
//given data :
N1=100;//turns
N2=80;//turns
I1=10;//A
I2=1.5;//A
li=40/100;//m
lg=1/1000;//m(airgap)
A=10/10000;//m^2
mur=2000;//relative permeability
mu0=4*%pi*10^-7;//permeability
mmf=N1*I1-N2*I2;//AT
S=1/(mu0*A)*[li/mur+lg];//AT/Wb
fi=mmf/S;//Wb
disp(fi,"Flux produced(Wb)");
```

Scilab code Exa 2.15 Calculate the current

```
//Ex_2_15
clc;
clear;
```

```
close;
format('v',5);
//given data :
N=2000;//turns
lg=2/1000;//m(airgap)
lc=20/100;//m(mean diameter)
Ac=10/10000;//m^2(cross section central limb)
Ao=5/10000;//m^2(cross section outer limb)
B=[1 1.1 1.2 1.3 1.4];//Wb/m^2
H=[550 650.750 820 870];//AT/m
fi=1.1/1000;//Wb
Bc=fi/Ac;//Wb/m^2(For central limb)
Bo=fi/Ao;//Wb/m^2(For outer limb)
for i=1:5
    if Bc==B(i) then
        H=H(i);//AT/m
B=B(i);//Wb/m^2
        break;
    end;
end;
lo=%pi*lc/2;//m(outer limb, including airgap)
//H=NI/l
NIc=H*lc;//AT//NI for central limb
NIo=H*(lo-lg);//AT//NI for outer limb
mu0=4*%pi*10^-7;//permeability of air
Hg=B/mu0;//AT/m
NIag=Hg*lg;////AT//NI for airgap
NI=NIc+NIo+NIag;//AT//Total AT required
I=NI/N;//A
disp(I,"Current I(A)");
```

Scilab code Exa 2.16 Calculate the flux

```
//Ex_2_16
clc;
```

```
clear;
close;
format('v',5);
//given data :
LA=75/100;///m
LB=25/100;///m
lg=2/100;//m(airgap)
mu_r1=1000;///relative permeability
mu_r2=1500;///relative permeability
mu0=4*%pi*10^-7;//permeability of air
A=10*10^-4;//m^2//Area of core
N=1000;//turns
I=5;//A
S=LA/(mu0*mu_r1*A)+LB/(mu0*mu_r2*A)+lg/(mu0*A);//Wb/
   m^2
fi=N*I/S*1000;//mWb
disp(fi,"Flux produced in the air-gap(mWb)");
```

Scilab code Exa 2.17 Calculate the magnetizing current

```
//Ex_2_17
clc;
clear;
close;
format('v',5);
//given data :
CD=10/100;BE=10/100;AF=10/100;//m
BC=8/100;ED=8/100;AB=8/100;EF=8/100;//m
BCDE=BC+CD+ED;//m
BAFE=AB+BE+EF;//m
A=2*2*10^-4;//m^2
mu_r=1200;///relative permeability
N=800;//turns
fi2=2*10^-3;//Wb
mu0=4*%pi*10^-7;//permeability of air
```

```
S2=BAFE/(mu0*mu_r*A);//Wb/m^2
S1=BE/(mu0*mu_r*A);//Wb/m^2
fi1=fi2*S2/S1;//Wb
fi=fi1+fi2;//Wb
AT2=fi*S2;//AT//for portion BAFE
AT1=fi1*S1;//AT//for portion BCDE
AT=AT1+AT2;//AT//Toal AT required
NI=AT;//AT
I=NI/N;//A
disp(I,"Magnetizing current(A)");
```

Scilab code Exa 2.18 Flux density and magnetic pull

```
//Ex_2_18
clc;
clear;
close;
format('v',7);
//given data :
lg=1/1000;//m//air-gap
li=20/100;//m//flux path
mu0=4*%pi*10^-7;//permeability of air
mu_r=500;///relative permeability
A=0.5*10^-4;//m^2//Area
I=50/1000;//A
N=8000;//turns
S=li/mu0/mu_r/A+2*lg/mu0/A;//AT/Wb
fi=N*I/S;//Wb
B=fi/A;//Wb/m^2
disp(B,"Flux Density(Wb/m^2)");
format('v',5);
F=B*A/2/mu0;//N
disp(F,"Magnetic Pull(N)");
```

Scilab code Exa 2.19 Calculate the magnetic field

```
//Ex_2_19
clc;
clear;
close;
format('v',7);
//given data :
I=100;//A
r=1;//m
mu0=4*%pi*10^-7;//permeability of air
B=mu0*I/2/%pi/r;//Wb/m^2
disp(B,"Magnetic field produced(Wb/m^2)");
```

Scilab code Exa 2.20 Calculate the resultant force

```
//Ex_2_20
clc;
clear;
close;
format('e',9);
//given data :
I1=100;//A
I2=10;//A
l=20/100;//m
r1=1/100;//m
r2=11/100;//m
mu0=4*%pi*10^-7;//permeability of air
//Force of attraction between Conductor & AB
F1=mu0*I1*I2*l/2/%pi/r1;//N
//Force of repulsion between Conductor & CD
F2=mu0*I1*I2*l/2/%pi/r2;//N
```

```
//Net Force
F=F1-F2;//N
disp(F,"Resultant force developed(N)");
```

Scilab code Exa 2.21 Value of exciting current

```
//Ex_2_21
clc;
clear;
close;
format('v',4);
//given data :
N=500;//turns
A=0.01;//m^2(Area of cross section of poles)
l=0.5;//m(mean length)
mu0=4*%pi*10^-7;//permeability of air
mu_r=1000;///relative permeability
g=9.8;//gravitational acceleration
W=200;//kg
F=W/2;//kg
F=F*g;//N
B=sqrt(F*2*mu0/A);//Wb/m^2
H=B/mu0/mu_r;//Wb/m^2
I=H*l/N;//A
disp(I,"Exciting current(A)");
```

Chapter 3

AC Fundamentals

Scilab code Exa 3.1 rms value of current

```
//Example 3_1
clc;
clear;
close;
format('v',6);
//given data :
//v=100*sin(314*t)
R=20;//ohm
Vm=100;//V
omega=314;//
Vrms=Vm/2;//V
Irms=Vrms/R;//A
disp(Irms,"rms value of current (A)");
```

Scilab code Exa 3.2 Frequency of the supply

```
//Example 3_2
clc;
```

```
clear;
close;
format('v',5);
//given data :
//v=150*sin(100*%pi*t)
R=50;//ohm
Vm=150;//V
omega=100*%pi;//
f=omega/2/%pi;//Hz
Vrms=Vm/2;//V
Vav=Vm/%pi;//V
Irms=Vm/2/R;//A
disp(Irms,"rms value of current (A)");
Iav=Vm/%pi/R;//A
disp(Iav,"Average value of current (A)");
Kf=Irms/Iav;//Form Factor
disp(Kf,"Form Factor")
```

Scilab code Exa 3.3 Form factor

```
//Example 3_3
clc;
clear;
close;
format('v',5);
//given data :
v=10;//V
T=0.2;//second
Vav=1/T*integrate('1*v','t',0,T/2);//V
Vrms=sqrt(1/T*integrate('v^2','t',0,T/2));//V
disp(Vrms,"rms value of Voltage (V)");
disp(Vav,"Average value of Voltage (V)");
Kf=Vrms/Vav;//Form Factor
disp(Kf,"Form Factor")
//Answer is not accurate in the book.
```

Scilab code Exa 3.4 Rms and average value

```
//Example 3_4
clc;
clear;
close;
format('v',5);
//given data :
//Let T=1 for calculation
T=1;
//i=5*t/T+5;//A
Iav=1/T*integrate('5*t/T+5','t',0,T);
disp(Iav,"Average value(A)");
Irms=sqrt(1/T*integrate('(5*t/T+5)^2','t',0,T));//V
disp(Irms,"rms value(A)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.5 Rms and average value and form factor

```
//Example 3_5
clc;
clear;
close;
format('v',5);
//given data :
//Let T=1 for calculation
T=1;
//y=m*x, m=10/T & x=t
//i=10*t/T
Im=10;//A
Irms=sqrt(1/T*integrate('(10*t/T)^2','t',0,T));//V
```

```
disp(Irms,"rms value(A)");
Iav=Im/2;//A
disp(Iav,"Average value(A)");
Kf=Irms/Iav;//Form Factor
disp(Kf,"Form Factor")
```

Scilab code Exa 3.6 Voltage and current

```
//Example 3_6
clc;
clear;
close;
format('v',5);
//given data :
L=0.5;//H
V=230;//V
f=50;//Hz
Vm=sqrt(2)*V;//V
XL=2*%pi*f*L;//ohm
I=V/XL;//A
Im=sqrt(2)*I;//A
disp("Equations are : ");
disp("V="+string(Vm)+"*sin"+string(2*%pi*f)+"*t");
disp("i="+string(Im)+"*sin("+string(2*%pi*f)+"*t-%pi
    /2)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.7 Instantaneous current

```
//Example 3_7
clc;
clear;
close;
```

```
format('v',6);
//given data :
L=0.5;//H
C=100;//micro F
V=230;//V
f=50;//Hz
R=25;//ohm
Vm=sqrt(2)*V;//V
omega=2*%pi*f;//rad/s
disp("Voltage equation")
disp("V="+string(Vm)+"*sin"+string(omega)+"*t");
XL=omega*L;//ohm
XC=1/omega/(C*10^-6);///ohm
disp("Current through the resistor will be ");
disp("i="+string(Vm/R)+"*sin("+string(2*%pi*f)+"*t)");
disp("Current through the inductor will be ");
disp("i="+string(Vm/XL)+"*sin("+string(2*%pi*f)+"*t-90)");
disp("Current through the capacitor will be ");
disp("i="+string(Vm/XC)+"*sin("+string(2*%pi*f)+"*t+90)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.8 Calculate the current

```
//Example 3_8
clc;
clear;
close;
format('v',5);
//given data :
V=100;//V
f=50;//Hz
R=10;//ohm
```

```
L=100;//mH
C=100;//micro F
XL=2*%pi*f*L*10^-3;//ohm
XC=1/2/%pi/f/(C*10^-6);//ohm
IR=V/R;//A
disp(IR,"Current through R(A)");
IL=V/XL;//A
disp(IL,"Current through L(A)");
IC=V/XC;//A
disp(IC,"Current through C(A)");
```

Scilab code Exa 3.9 Branch and Line current Power factor

```
//Example 3_9
clc;
clear;
close;
format('v',5);
//given data :
V=230;//V
f=50;//Hz
R1=14;//ohm
L1=16;//mH
R2=18;//ohm
L2=32;//mH
XL1=2*%pi*f*L1*10^-3;//ohm
XL2=2*%pi*f*L2*10^-3;//ohm
Z1mag=sqrt(R1^2+XL1^2);//ohm
Z2mag=sqrt(R2^2+XL2^2);//ohm
fi1=atand(XL1/R1);//radian
fi2=atand(XL2/R2);//radian
Z1=Z1mag*expm(%i*fi1*%pi/180);//ohm
Z2=Z2mag*expm(%i*fi2*%pi/180);//ohm
Y1=1/Z1;//mho
Y2=1/Z2;//mho
```

```
I1=V*Y1;//A
I1mag=abs(I1);//A
I1ang=atand(imag(I1),real(I1));//degree
disp(I1ang,I1mag,"Branch Current I1, magnitude(A) &
    angle(degree) are: ");
I2=V*Y2;//A
I2mag=abs(I2);//A
I2ang=atand(imag(I2),real(I2));//degree
disp(I2ang,I2mag,"Branch Current I2, magnitude(A) &
    angle(degree) are: ");
I_cosfi=I1mag*cosd(fi1)+I2mag*cosd(fi1);
I_sinfi=I1mag*sind(fi1)+I2mag*sind(fi1);
tanfi=I_sinfi/I_cosfi;
fi=atand(tanfi);//degree
pf=cosd(fi);//Power Factor lagging
disp(pf,"Total Power Factor(lagging)");
I=sqrt(I_sinfi^2+I_cosfi^2);//A
disp(fi,-I,"Line Current I, magnitude(A) & angle(
    degree) are: ");
//Answer is not accurate in the book.
```

Scilab code Exa 3.10 Apparent Real and active power

```
//Example 3_10
clc;
clear;
close;
format('v',6);
//given data :
V=200;//V
f=50;//Hz
R=40;//ohm
L=0.0637;//H
XL=2*%pi*f*L;//ohm
IR=V/R;//A
```

```
IL=V/XL;//A
I=sqrt(IR^2+IL^2);//A
disp(I,"(a) Current drawn from supply(A)");
S=V*I/1000;//kVA
disp(S,"(b) Apparent Power(kVA)");
P=V*IR/1000;//kW
disp(P,"(c) Real Power(kW)");
```

Scilab code Exa 3.11 Current Power factor and power

```
//Example 3_11
clc;
clear;
close;
format('v',6);
//given data :
V=100;//V
f=50;//Hz
R1=8;//ohm
X1=6;//ohm
R2=6;//ohm
X2=-8;//ohm
Z1=R1+%i*X1;//ohm
Z2=R2+%i*X2;//ohm
I1=V/Z1;//A
I1mag=abs(I1);//A
I1ang=atand(imag(I1),real(I1));//degree
disp(I1ang,I1mag,"Branch Current I1, magnitude(A) &
    angle(degree) are: ");
I2=V/Z2;//A
I2mag=abs(I2);//A
I2ang=atand(imag(I2),real(I2));//degree
disp(I2ang,I2mag,"Branch Current I2, magnitude(A) &
    angle(degree) are: ");
I=I1+I2;//A
```

```
Imag=abs(I);//A
Iang=atand(imag(I),real(I));//degree
disp(Iang,Imag,"Total Current I, magnitude(A) & angle(degree) are: ");
fi=atand(imag(I),real(I));//degree
pf=cosd(fi);//Power Factor lagging
disp(pf,"Total Power Factor(lagging)");
P=V*Imag*cosd(fi);//W
disp(P,"Active Power(W)");
S=V*Imag*sind(fi);//VAR
disp(S,"Reactive Power(VAR)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.12 Current Power factor and power

```
//Example 3_12
clc;
clear;
close;
format('v',6);
//given data :
V=230;//V
f=50;//Hz
R=5;//ohm
L=30;//mH
XL=2*%pi*f*L*10^-3;//ohm
Z=R+%i*XL;//ohm
I=V/Z;//A
Imag=abs(I);//A
disp(Imag,"Magnitude of current(A) : ");
fi=atand(imag(I),real(I));//degree
format('v',5);
pf=cosd(fi);//Power Factor
disp(pf,"Power Factor(lagging)");
P=V*Imag*cosd(fi);//W
```

```
disp(P,"Power Consumed(W) : " );
//Answer is not accurate in the book.
```

Scilab code Exa 3.13 Current Power factor and power

```
//Example 3_13
clc;
clear;
close;
format('v',6);
//given data :
V=230;//V
f=50;//Hz
R=15;//ohm
L=0.15;//H
C=100;//micro F
XL=2*%pi*f*L;//ohm
XC=1/2/%pi/f/(C*10^-6);//ohm
Z=R+%i*(XL-XC);//ohm
I=V/Z;//A
Imag=abs(I);//A
fi=atand(imag(I),real(I));//degree
disp(Imag,"Magnitude of current(A) : ");
disp(fi,"Angle(lagging) of current(degree) : ");
format('v',7);
pf=cosd(fi);//Power Factor
disp(pf,"Power Factor(lagging)");
P=V*Imag*cosd(fi);//W
disp(P,"Power Consumed(W) : " );
//Answer is not accurate in the book.
```

Scilab code Exa 3.14 Value of Z2

```
//Example 3_14
clc;
clear;
close;
format('v',5);
//given data :
V=230;//V
f=50;//Hz
V1=120*expm(%i*30*%pi/180);//V
Z1=15*expm(%i*40*%pi/180);//ohm
V2=V-V1;//V
I=V1/Z1;//A
Z2=V2/I;//ohm
R=real(Z2);//ohm
XC=imag(Z2);//ohm
C=-1/2/%pi/f/XC*10^6;//micro F
disp(Z2,"Value of Z2(ohm) : ");
disp(R,"Resistance(ohm)");
format('v',7);
disp(C,"Capacitance(micro F)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.15 Impedence Power factor and Power

```
//Example 3_15
clc;
clear;
close;
format('v',5);
//given data :
f=50;///Hz
V=160+%i*170;//V
I=12-%i*5;//A
Z=V/I;//ohm
disp(Z,"Impedence Z(ohm)");
```

```
fi=atand(imag(Z)/real(Z));//degree
pf=cosd(fi);//Power Factor
disp(pf,"Power Factor(lagging)");
P=abs(V)*abs(I)*pf;//W
disp(P,"Power Consumed(W)");
XL=imag(Z);//ohm
L=XL/2/%pi/f*1000;//mH
disp(L,"Inductance L(mH)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.16 Value of L and R

```
//Example 3_16
clc;
clear;
close;
format('v',5);
//given data :
//v=325*sin(314*t)
//i=14.14*sin(314*t-60)
Vm=325;//V
omega=314;//rad/s
V=Vm/sqrt(2);//V
f=omega/2/%pi;//Hz
Im=14.14;//A
I=Im/sqrt(2);//A
fi=60;//degree
pf=cosd(fi);//power factor
P=V*I*cosd(fi);//W
disp(P,"Powe Consumed(W)");
Z=V/(I*expm(%i*-fi*%pi/180));//ohm
R=real(Z);//ohm
disp(R,"Value of R(ohm)");
XL=imag(Z);//ohm
L=XL/2/%pi/f*1000;//mH
```

```
disp(L,"Value of L(mH)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.17 Value of R

```
//Example 3_17
clc;
clear;
close;
format('v',5);
//given data :
L=100;//mH
f=50;//Hz
XL=2*%pi*f*L/1000;///ohm
//VL should be equal to 1/2*V
//equalting : VL=I*XL & 1/2*V=1/2*I*Z=1/2*I*sqrt(R^2+XL^2)
R=sqrt(3*XL^2);//ohm
disp(R,"Value of R(ohm)");
```

Scilab code Exa 3.18 Value of L and R

```
//Example 3_18
clc;
clear;
close;
format('v',6);
//given data :
//v=100*sin(314*t)
//i=10*sin(314*t-%pi/6)
Vm=100;//V
omega=314;//rad/s
V=Vm/sqrt(2);//V
```

```
f=omega/2/%pi;//Hz
Im=10;//A
I=Im/sqrt(2);//A
fi=%pi/6;//radian
pf=cos(fi);//power factor
disp(pf,"Power Factor(Lagging)");
P=V*I*cos(fi);//W
disp(P,"Powe Consumed(W)");
Z=V/(I*expm(%i*-fi));//ohm
R=real(Z);//ohm
disp(R,"Value of R(ohm)");
XL=imag(Z);//ohm
L=XL/2/%pi/f*1000;//mH
disp(L,"Value of L(mH)");
```

Scilab code Exa 3.19 Power Impedence R and L

```
//Example 3_19
clc;
clear;
close;
format('v',6);
//given data :
//v=200*sin(314*t+%pi/3)
//i=20*sin(314*t+%pi/6)
Vm=200;//V
omega=314;//rad/s
V=Vm/sqrt(2);//V
f=omega/2/%pi;//Hz
Im=20;//A
I=Im/sqrt(2);//A
fi=%pi/3-%pi/6;//radian
pf=cos(fi);//power factor
disp(pf,"(i) Power Factor(Lagging)");
P=V*I*cos(fi);//W
```

```
disp(P,"(ii) Average Power(W)");
Z=V/(I*expm(%i*-fi));//ohm
Zmag=abs(Z);//ohm
Zang=atand(imag(Z),real(Z));//degree
disp(Zang,Zmag,"(iii) Impedence in polar form,
    Magnitude(ohm) & angle(degree) are");
disp(Z,"(iii) Impedence in rectangular form(ohm)");
R=real(Z);//ohm
disp(R,"(iv)Value of R(ohm)");
XL=imag(Z);//ohm
L=XL/2/%pi/f*1000;//mH
disp(L,"(iv)Value of L(mH)");
```

Scilab code Exa 3.20 Voltage and power factor

```
//Example 3_20
clc;
clear;
close;
format('v',4);
//given data :
VR=20;//V
VL=60;//V
VC=30;//V
V=sqrt(VR^2+(VL-VC)^2);//V
disp(V,"Magnitude of voltage(V)");
format('v',5);
fi=acosd(VR/V);//degree
disp(fi,"Power Factor angle(degree)");
pf=cosd(fi);//Power Factor
disp(pf,"Power Factor");
//Answer is not accurate in the book.
```

Scilab code Exa 3.21 Value of R and C

```
//Example 3_21
clc;
clear;
close;
format('v',5);
//given data :
L=100;//mH
//i=14.148sin(314*t+%pi/6)
//v=325*sin(314*t)
Vm=325;//V
Im=14.14;//A
omega=314;//rad/s
V=Vm/sqrt(2);//V
I=Im/sqrt(2);//A
Z=V/(I*expm(%i*%pi/6));//ohm
R=real(Z);//ohm
disp(R,"Value of R(ohm)");
XCL=-imag(Z);//ohm//XCL=XC-XL
XC=XCL+omega*L/1000;//ohm
C=1/XC/omega;//F
C=C*10^6;//micro F
disp(C,"Value of C(micro F)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.22 Current and power factor

```
//Example 3_22
clc;
clear;
close;
format('v',6);
//given data :
L=100;//mH
```

```
R=15;//ohm
V=230;//V
f=50;//Hz
XL=2*%pi*f*L/1000;//ohm
IR=V/R;//A
disp(IR,"Branch Current IR(A)");
IL=V/XL;//A
format('v',5);
disp(IL,"Branch Current IL(A)");
I=sqrt(IR^2+IL^2);//A
disp(I,"Line Current I(A)");
pf=IR/I;//Power factor(lagging)
disp(pf,"Power Factor(lagging)");
fi=acosd(pf);//degree
P=V*I*cosd(fi);//W
disp(P,"Power Consumed(W)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.23 Current and power factor

```
//Example 3_23
clc;
clear;
close;
format('v',6);
//given data :
R1=5;//ohm
L1=150;//mH
R2=50;//ohm
L2=15;//mH
V=230;//V
f=50;//Hz
Z1=R1+%i*2*%pi*f*L1/1000;//ohm
Z2=R2+%i*2*%pi*f*L2/1000;//ohm
I1=V/Z1;//A
```

```
I2=V/Z2;//A
I=I1+I2;//A
Imag=abs(I);//A
Iang=atand(imag(I)/real(I));//degree
disp(Iang,Imag,"Total current drawn, magnitude(A) &
    Angle(degree) are");
pf=cosd(Iang);//Power Factor(lagging)
format('v',4);
disp(pf,"Power Factor(lagging)");
P=V*Imag*pf;//W
format('v',5);
disp(P,"Power Consumed(W)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.24 Current and Power

```
//Example 3_24
clc;
clear;
close;
format('v',6);
//given data :
Z1=10+%i*12;//ohm
Z2=12-%i*10;//ohm
V=230;//V
f=50;//Hz
Z=Z1*Z2/(Z1+Z2);//ohm
I=V/Z;//A
Imag=abs(I);//A
Iang=atand(imag(I)/real(I));//degree
disp(Iang,Imag,"Total current drawn, magnitude(A) &
    Angle(degree) are");
pf=cosd(Iang);//Power Factor(lagging)
format('v',6);
disp(pf,"Power Factor(lagging)");
```

```
P=V*Imag*pf;//W
P=P/1000;//kW
disp(P,"Power Consumed(kW)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.25 Apparent and reactive power

```
//Example 3_25
clc;
clear;
close;
format('v',6);
//given data :
R1=12;//ohm
L=50;//mH
R2=50;//ohm
C=50;//micro F
V=200*expm(%i*30*%pi/180);//V
f=50;//Hz
XL=2*%pi*f*L/1000;//ohm
XC=1/2/%pi/f/(C*10^-6);//ohm
Z1=R1+%i*XL;//ohm
Z2=R2+%i*XC;//ohm
I1=V/Z1;//A
I2=V/Z2;//A
I=I1+I2;//A
Imag=abs(I);//A
Iang=atand(imag(I)/real(I));//degree
disp(Iang,Imag,"Total current drawn, magnitude(A) &
    Angle(degree) are");
pf=cosd(Iang);//Power Factor(lagging)
fi=acosd(pf);//degree
disp(pf,"Power Factor(lagging)");
P=abs(V)*Imag*pf;//W
P=P/1000;//kW
```

```
disp(P,"Power Consumed(kW)");
S=abs(V)*Imag*sind(fi);//VARs
S=S/1000;//kVARs
disp(S,"Reactive Power (kVARs)");
Pa=abs(V)*Imag/1000;//kVA
disp(Pa,"Apparent Power(kVA)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.26 Admittance and power factor

```
//Example 3_26
clc;
clear;
close;
format('v',6);
//given data :
V=230;//V
f=50;//Hz
Z1=12*expm(%i*30*%pi/180);//ohm
Z2=8*expm(%i*-30*%pi/180);//ohm
Z3=10*expm(%i*60*%pi/180);//ohm
Y1=1/Z1;//mho
Y2=1/Z2;//mhob
Y3=1/Z3;//mho
Y=Y1+Y2+Y3;//mho
Ymag=abs(Y);//mho
Yang=atand(imag(Y)/real(Y));//degree
disp(Yang,Ymag,"Total admittance, magnitude(mho) &
    Angle(degree) are");
Z=1/Y;//ohm
Zmag=abs(Z);//ohm
Zang=atand(imag(Z)/real(Z));//degree
disp(Zang,Zmag,"Equivallent Impedance, magnitude(ohm
    ) & Angle(degree) are");
I=V/Z;//A
```

```
Imag=abs(I);//A
Iang=atand(imag(I)/real(I));//degree
disp(Iang,Imag,"Total current, magnitude(A) & Angle(
    degree) are");
pf=cosd(Iang);//Power Factor(lagging)
fi=acosd(pf);//degree
disp(pf,"Power Factor(lagging)");
format('v',7);
P=abs(V)*Imag*pf;//W
P=P/1000;//kW
disp(P,"Power Consumed(kW)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.27 Calculate power and power factor

```
//Example 3_27
clc;
clear;
close;
format('v',6);
//given data :
V=230;//V
f=50;//Hz
R1=12;//ohm
XL1=12;//ohm
R2=8;//ohm
XL2=16;//ohm
Z1=R1+%i*XL1;//ohm
Z2=R2+%i*XL2;//ohm
Y1=1/Z1;//mho
Y2=1/Z2;//mhob
I1=V*Y1;//A
I1mag=abs(I1);//A
I1ang=atand(imag(I1)/real(I1));//degree
disp(I1ang,I1mag,"current I1, magnitude(A) & Angle(
```

```
degree) are");
I2=V*Y2;//A
I2mag=abs(I2);//A
I2ang=atand(imag(I2)/real(I2));//degree
disp(I2ang,I2mag,"Current I2, magnitude(A) & Angle(degree) are");
I=I1+I2;//A
Imag=abs(I);//A
Iang=atand(imag(I)/real(I));//degree
disp(Iang,Imag,"Total current, magnitude(A) & Angle(degree) are");
pf=cosd(Iang);//Power Factor(lagging)
fi=acosd(pf);//degree
disp(pf,"Power Factor(lagging)");
P=abs(V)*Imag*pf;//W
P=P/1000;//kW
disp(P,"Power Consumed(kW)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.28 Total Current drawn

```
//Example 3_28
clc;
clear;
close;
format('v',5);
//given data :
V=230;//V
f=50;//Hz
R1=10;//ohm
L1=0.0636;//H
R2=8;//ohm
C=398;//micro F
R3=6;//ohm
L2=0.0319;//H
```

```
Z1=R1+%i*2*%pi*f*L1;//ohm
Z2=R2-%i/2/%pi/f/(C*10^-6);//ohm
Z3=R3+%i*2*%pi*f*L2;//ohm
Z=Z1*Z2/(Z1+Z2)+Z3;//ohm
I=V/Z;//A
Imag=abs(I);//A
Iang=atand(imag(I)/real(I));//degree
disp(Iang,Imag,"Current, magnitude(A) & Angle(degree
    ) are");
disp(Imag,"Total Current(A)");
pf=cosd(Iang);//Power Factor(lagging)
fi=acosd(pf);//degree
disp(pf,"Power Factor(lagging)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.29 Value of R

```
//Example 3_29
clc;
clear;
close;
format('v',4);
//given data :
V=230;//V
I=25;//A
f=50;//Hz
R1=5;//ohm
R2=10;//ohm
L2=50;//mH
Z1=R1;//ohm
Z2=R2+%i*2*%pi*f*L2/1000;//ohm
R=poly(0,'R');
Z3=R;//ohm
Z12=Z1*Z2/(Z1+Z2);//ohm
Z=V/I;//ohm//Zdash is Z durectly
```

```
R3=Z-Z12;//ohm
R3=real(R3);//ohm
disp(R3,"Value of R(ohm)");
```

Scilab code Exa 3.30 Current and power factor

```
//Example 3_30
clc;
clear;
close;
format('v',5);
//given data :
V=200;//V
f=50;//Hz
ZA=4+%i*3;//ohm
ZB=10-%i*7;//ohm
ZC=6+%i*5;//ohm
Z=ZC+ZA*ZB/(ZA*ZB);//ohm
IC=V/Z;//A
ICmag=abs(IC);//A
ICang=atand(imag(IC)/real(IC));//degree
disp(ICang,ICmag,"Current IC, magnitude(A) & Angle(
    degree) are");
IA=IC*ZB/(ZA+ZB);//A
IAmag=abs(IA);//A
IAang=atand(imag(IA)/real(IA));//degree
disp(IAang,IAmag,"Current IA, magnitude(A) & Angle(
    degree) are");
IB=IC*ZA/(ZA+ZB);//A
IBmag=abs(IB);//A
IBang=atand(imag(IB)/real(IB));//degree
disp(IBang,IBmag,"Current IB, magnitude(A) & Angle(
    degree) are");
fi=ICang;//degree//angle of pf
pf=cosd(fi);//Power Factor(lagging)
```

```
disp(pf,"Power Factor(lagging)");
VC=IC*ZC;//V
VCmag=abs(VC);//A
VCang=atand(imag(VC)/real(VC));//degree
disp(VCang,VCmag,"Voltage VC, magnitude(V) & Angle(
    degree) are");
VA=IC*ZA*ZB/(ZA+ZB);//V
VAmag=abs(VA);//A
VAang=atand(imag(VA)/real(VA));//degree
disp(VAang,VAmag,"Voltage VA, magnitude(V) & Angle(
    degree) are");
VB=IC*ZA*ZB/(ZA+ZB);//V
VBmag=abs(VB);//A
VBang=atand(imag(VB)/real(VB));//degree
disp(VBang,VBmag,"Voltage VB, magnitude(V) & Angle(
    degree) are");
//Answer is not accurate in the book.
```

Scilab code Exa 3.31 Determine the voltage

```
//Example 3_31
clc;
clear;
close;
format('v',5);
//given data :
I2=10;//A
f=50;//Hz
R1=5;//ohm
L1=0.0191;//H
R2=7;//ohm
C2=398;//micro F
R3=8;//ohm
L3=0.0318;//H
Z1=R1+%i*2*%pi*f*L1;//ohm
```

```
Z2=R2-%i/2/%pi/f/(C2*10^-6);//ohm
Z3=R3+%i*2*%pi*f*L3;//ohm
VAC=I2*Z2;//V
I1=VAC/Z1;//A
I=I1+I2;//A
VCB=I*Z3;//V
VAB=VAC+VCB;//V
VABmag=abs(VAB);//A
VABang=atand(imag(VAB)/real(VAB));//degree
disp(VABang,VABmag,"Voltage AB, magnitude(V) & Angle(degree) are");
//Answer is not accurate in the book.
```

Scilab code Exa 3.32 Impedence Current and power

```
//Example 3_32
clc;
clear;
close;
format('v',6);
//given data :
V=110;//V
f=50;//Hz
ZA=2;//ohm
ZB=3+%i*4;//ohm
ZC=2-%i*2;//ohm
ZAB=ZA*ZB/(ZA+ZB);//ohm
ZP=ZAB*ZC/(ZAB+ZC);//ohm
ZD=1+%i*1;//ohm
z=ZP+ZD;//ohm
zmag=abs(z);//A
zang=atand(imag(z)/real(z));//degree
disp(zang,zmag,"(a) Total impedence, magnitude(ohm) & Angle(degree) are");
I=V/abs(z);//A
```

```
format('v',5);
disp(I,"(b) Current taken by circuit(A)");
format('v',7);
ID=I;//A
RD=real(ZD);//ohm
PD=ID^2*RD;///W
disp(PD,"Power Consumed by branch D(W)");
//VPQ=I*ZP;
IA=I*abs(ZP)/abs(ZA);//A
RA=2;//ohm
PA=IA^2*RA;//W
disp(PA,"Power Consumed by branch A(W)");
IB=I*abs(ZP)/abs(ZB);//A
RB=3;//ohm
PB=IB^2*RB;//W
disp(PB,"Power Consumed by branch B(W)");
IC=I*abs(ZP)/abs(ZC);//A
RC=2;//ohm
PC=IC^2*RC;//W
disp(PC,"Power Consumed by branch C(W)");
P=PA+PB+PC+PD;//W
disp(P,"Total Power Consumed(W)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.33 Frequency and Q factor

```
//Example 3_33
clc;
clear;
close;
format('v',5);
//given data :
R=10;///ohm
L=0.1;//H
C=8;//micro F
```

```
f0=1/2/%pi/sqrt(L*C*10^-6);//Hz
disp(f0,"(a) Resonant Frequency(Hz)");
Q=2*%pi*f0*L/R;//Q-factor
disp(Q,"(b) Q-factor");
f1=f0-R/4/%pi/L;//Hz
f2=f0+R/4/%pi/L;//Hz
disp(f2,f1,"(c) Half power frequencies , f1 & f2 in
   Hz are");
BW=f2-f1;//Hz
disp(BW,"Bandwidth(Hz)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.34 Capacitance and Q factor

```
//Example 3_34
clc;
clear;
close;
format('v',6);
//given data :
R=4;///ohm
L=0.5;//H
V=100;///V
f=50;//Hz
C=(1/2/%pi/f)^2/L*10^6;//micro F
disp(C,"(a) Capacitance at resonant Frequency(micro
   F)");
I0=V/R;//A
VC=I0/2/%pi/f/(C*10^-6);//V
disp(VC,"(b) Voltage across the capacitor at
   resonant(V)");
Q=VC/V;//Q-factor
disp(Q,"(b) Q-factor");
//Answer is not accurate in the book.
```

Scilab code Exa 3.35 Circuit parameters

```
//Example 3_35
clc;
clear;
close;
format('v',6);
//given data :
V=230;///V
f=50;//Hz
Im=1.5;//A//Maximum current
VC=600;//V
VL=600;//V
R=V/Im;//ohm
XL=VL/Im;//ohm
L=XL/2/%pi/f;//H
XC=XL;//ohm
C=1/2/%pi/f/XC;//F
disp(R,"Resistance(ohm)");
format('v',5);
disp(L,"Inductance(H)");
format('v',11);
disp(C,"Capacitance(F)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.36 Circuit parameters and Q factors

```
//Example 3_36
clc;
clear;
close;
format('v',6);
```

```
//given data :
f=100;//Hz
C=100;//micro F
Cdash=200;//micro F//When current is half of maximum
L=1/(2*%pi*f)^2/(C*10^-6);//H
disp(L,"Inductance(H)");
XL=2*%pi*f*L;//ohm
XC=1/2/%pi/f/(Cdash*10^-6);//ohm
//at I=Im/2  Z will be 2*R
//Im=V/R and I=V/Z=V/sqrt(R^2+(XL-XC)^2)
R=(XL-XC)/sqrt(3);//ohm
format('v',5);
disp(R,"Resistance(ohm)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.37 Voltage and Q factor

```
//Example 3_37
clc;
clear;
close;
format('v',5);
//given data :
R=10;//ohm
L=20;//mH
C=10;//micro F
V=50;//V
f0=1/2/%pi/sqrt(L/1000*C/10^6);//Hz
disp(f0,"Resonance frequency(Hz)");
I0=V/R;//A
XL=2*%pi*f0*L/1000;//ohm
VL=I0*XL;//V
disp(VL,"Voltage across inductance(V)");
VR=I0*R;//V
disp(VR,"Voltage across Resistance(V)");
```

```
XC=1/2/%pi/f0/(C*10^-6);//ohm
VC=I0*XC;//V
disp(VC,"Voltage across Capacitance(V)");
Q=VL/V;//Q-factor
disp(Q,"Q-factor");
//Answer is not accurate in the book.
```

Scilab code Exa 3.38 Value of C and voltage

```
//Example 3_38
clc;
clear;
close;
format('v',7);
//given data :
R=50;//ohm
L=1;//mH
Im=5;//A//Maximum current
f0=50;//Hz
C=1/(2*%pi*f0)^2/(L/1000);//F
disp(C,"Value of C(F)");
V=Im*R;///V
disp(V,"Applied Voltage(V)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.39 Power factor Impedence and current

```
//Example 3_39
clc;
clear;
close;
format('v',10);
//given data :
```

```
R=2.5; //ohm
XL=25; //ohm
V=200; //V
f0=50; //Hz
XC=XL; //ohm
C=1/(2*%pi*f0*XC); //F
disp(C,"For maximum current , Value of C(F)");
//At resonance Z=R
pf=1; //power factor
disp(pf,"Power Factor ");
Z=R; //ohm
disp(Z,"Impedence(ohm)");
Im=V/R; //A
disp(Im,"Current(A)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.40 Frequency Q factor and current

```
//Example 3_40
clc;
clear;
close;
format('v',7);
//given data :
R=10; //ohm
L=100; //mH
C=20; //micro F
V=100; //V
f0=1/2/%pi*sqrt(1/(L/1000*C*10^-6)-R^2/(L/1000)^2);
    //Hz
disp(f0,"Resonant frequency(Hz)");
Q=2*%pi*f0*L/1000/R; //Q-factor
disp(Q,"Q-factor");
Z0=L/1000/(C*10^-6)/R; //ohm
disp(Z0,"Dynamic Impedence(ohm)");
```

```
I0=V/Z0;//A
disp(I0,"Current at resonance(A)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.41 Value of capacitor

```
//Example 3_41
clc;
clear;
close;
format('v',6);
//given data :
R=5;//ohm
XL=10;//ohm
V=230;//V
f=50;//Hz
Z=R+%i*XL;//ohm
IL=V/Z;//A
fi_L=atand(imag(IL)/real(IL));//degree
IC=abs(IL)*sind(fi_L);//A
XC=-V/IC;//ohm
C=1/2/%pi/f/XC*10^6;//micro F
disp(C,"Value of capacitor(micro F)");
I=abs(IL)*cosd(fi_L);//A
format('v',3);
disp(I,"Magnitude of in-phase current(A)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.42 Resonant current

```
//Example 3_42
clc;
clear;
```

```
close;
format('v',7);
//given data :
R=4;//ohm
L=20;//mH
V=230;//V
f=50;//Hz
omega=2*%pi*f;//rad/s
ZL=R+%i*omega*L/1000;//ohm
IL=V/ZL;//A
fi_L=atand(imag(IL)/real(IL));//degree
IC=abs(IL)*sind(fi_L);//A
XC=-V/IC;//ohm
C=1/2/%pi/f/XC*10^6;//micro F
disp(C,"Value of capacitor(micro F)");
I0=abs(IL)*cosd(fi_L);//A
format('v',5);
disp(I0,"Magnitude of in-phase current(A)");
//Answer is not accurate in the book.
```

Scilab code Exa 3.43 Value of Ri

```
//Example 3_43
clc;
clear;
close;
format('v',6);
//given data :
XL1=6;//ohm
R2=10;//ohm
XC2=4;//ohm
R1=poly(0,'R1');
Z1=R1+%i*XL1;//ohm
Z2=R2-%i*XC2;//ohm
Z=Z1*Z2/(Z1+Z2);//ohm
```

```
//Imaginary part of Z will be zero
//For Calculation
eq=imag(numer(Z)*denom(Z'));//equaltion of imaginary
    part
R1=roots(eq);//ohm
R1=R1(1);//ohm//leaving -ve value
disp(R1,"Value of R1(ohm)");
```

Chapter 4

Semiconductor Fundamentals

Scilab code Exa 4.1 Value of wave vector

```
//Example 4_1
clc;
clear;
close;
format('v',9)
//given data :
E=2;//eV
c=3*10^8;//m/s//Speed of light
h=6.64*10^-34;//Js//Planks Constant
E=E*1.6*10^-19;//J
lambda=c*h/E;//m
lambda=lambda/10^-10;//Angstrum
disp(lambda,"Wavelength(Angstrum)");
k=2*%pi/(lambda*10^-10);//m^-1
disp(k,"k-vector(m^-1)");
```

Scilab code Exa 4.2 Identify the semicnductor

```
//Example 4_2
clc;
clear;
close;
format('v',7)
//given data :
c=3*10^8;//m/s//Speed of light
h=1.05*10^-34;//Js//Planks Constant
lambda=0.5;//micro m///or less
lambda=lambda/10^6;//m
Eg=2*%pi*h*c/lambda;//J
Eg=Eg/(1.6*10^-19);//eV
disp(Eg,"Bandgap Eg(eV)");
disp("Semiconductors Guess: C, BN, GaN & SiC");
```

Scilab code Exa 4.3 Calculate the energy of electron

```
//Example 4_3
clc;
clear;
close;
format('v',4)
//given data :
c=3*10^8;//m/s//Speed of light
h=1.05*10^-34;//Js//Planks Constant
mc=0.1;//mo
mc=mc*0.91*10^-30;//kg
k=0.3;///per Angstrum
E=h^2*(k/10^-10)^2/2/mc;//J
E=E/(1.6*10^-19);//eV
disp(E,"Energy of the electron(eV)");
```

Scilab code Exa 4.4 Calculate the energy of electron

```
//Example 4_4
clc;
clear;
close;
format('v',6)
//given data :
c=3*10^8;//m/s//Speed of light
h=1.05*10^-34;//Js//Planks Constant
mc_GaAs=0.067;//mo
mc_InAs=0.01;//mo
k=0.01;///per Angstrum
mc_GaAs=mc_GaAs*0.91*10^-30;//kg
mc_InAs=mc_InAs*0.91*10^-30;//kg
E_GaAs=h^2*(3*k*10^10)^2/2/mc_GaAs;//J
E_GaAs=E_GaAs/(1.6*10^-19)*1000;//meV
disp(E_GaAs,"Energy of the electron in GaAs(meV)");
E_InAs=h^2*(3*k*10^10)^2/2/mc_InAs;//J
E_InAs=E_InAs/(1.6*10^-19)*1000;//meV
disp(E_InAs,"Energy of the electron in InAs(meV)");
//Answer given in the textbook is wrong.
```

Scilab code Exa 4.5 Calculate the energy of electron

```
//Example 4_5
clc;
clear;
close;
format('v',6)
//given data :
c=3*10^8;//m/s//Speed of light
h=1.05*10^-34;//Js//Planks Constant
mc=0.067;//mo
k=[0.1 0.1 0 0];///per Angstrum
mc=mc*0.91*10^-30;//kg
E=h^2*((k(1)*10^10)^2+(k(2)*10^10)^2)/2/mc;//J
```

```
E=E/(1.6*10^-19);//eV
disp(E,"Energy of the electron in GaAs(eV)");
//Answer given in the textbook is wrong.
```

Scilab code Exa 4.6 Estimate smallest k vector

```
//Example 4_6
clc;
clear;
close;
format('v',8)
//given data :
c=3*10^8;//m/s//Speed of light
h=1.05*10^-34;//Js//Planks Constant
mc=0.067;//mo
mc=mc*0.91*10^-30;//kg
E=0.3;//eV
E=E*1.6*10^-19;//J
//Formula//E=3*h^2*kx^2/2/mc
kx=sqrt(2*mc*E/3/h^2);//m^-1
disp(kx,"Smallest k-vector along x-direction(m^-1)")
    ;
```

Scilab code Exa 4.7 Calculate the energy of electron

```
//Example 4_7
clc;
clear;
close;
format('v',6)
//given data :
c=3*10^8;//m/s//Speed of light
h=1.05*10^-34;//Js//Planks Constant
```

```
mc_GaAs=0.067;//mo
mc_InAs=0.01;//mo
k=[0.01 0.01 0.01];///per Angstrum
mc_GaAs=mc_GaAs*0.91*10^-30;//kg
mc_InAs=mc_InAs*0.91*10^-30;//kg
E_GaAs=h^2*(3*k(1)*10^10)^2/2/mc_GaAs;//J
E_GaAs=E_GaAs/(1.6*10^-19)*1000;//meV
disp(E_GaAs,"Energy of the electron in GaAs(meV)");
E_InAs=h^2*(3*k(1)*10^10)^2/2/mc_InAs;//J
E_InAs=E_InAs/(1.6*10^-19)*1000;//meV
disp(E_InAs,"Energy of the electron in InAs(meV)");
//Answer given in the textbook is wrong.
```

Scilab code Exa 4.8 Position of fermi level

```
//Example 4_8
clc;
clear;
close;
format('v',6)
//given data :
n0=6*10^17;//cm^-3
Nc=4.45*10^17;//cm^-3
kBT=0.026;//eV//at room temperature/T=300 K
EF=kBT*log(n0/Nc)*1000;//meV
disp(EF,"Position of fermi level(meV)");
```

Scilab code Exa 4.9 Position of fermi level

```
//Example 4_9
clc;
clear;
close;
```

```
format('v',6)
//given data :
//me=2*mh
meBYmh=2;//ratio
T=300;//K
kT=0.026;//eV//at room temperature/T=300 K
//EF=3/4*kT*log(1/meBYmh)-EG/2
//position of fermi level below centre of forbidden
   gap
EF=-3/4*kT*log(1/meBYmh);//eV
disp(EF,"Position of fermi level below centre of
   forbidden gap by (eV) : ");
```

Scilab code Exa 4.10 Position of fermi level

```
//Example 4_10
clc;
clear;
close;
format('v',7)
//given data :
h=1.05*10^-34;//Js//Planks Constant
mc=0.067;//mo
mc=mc*0.91*10^-30;//kg
n0=10^18;//cm^-3
n0=n0*10^6;//m^-3
EF=(h^2/2/mc)*(3*%pi^2*n0)^(2/3);//J
EF=EF/(1.6*10^-19);//eV
disp(EF,"Position of fermi level(eV)");
//Answer given in the textbook is wrong
```

Scilab code Exa 4.11 Calculate the time

```
//Example 4_11
clc;
clear;
close;
format('v',6)
//given data :
h=1.05*10^-34;//Js//Planks Constant
e=1.6*10^-19;//C///Charge on electron
E0=10^4;//V/cm
a=5.62*10^-8;//cm//lattice constant for n-GaAs
kB=2*%pi/a;//cm^-1///Brillouin Edge
tau=h*kB/e/E0*10^12;//ps
disp(tau,"Time taken by electron to reach Brillouin
    Zone(ps)");
//Answer given in the textbook is wrong
```

Scilab code Exa 4.12 Calculate the drift velocity

```
//Example 4_12
clc;
clear;
close;
format('e',9)
//given data :
h=1.05*10^-34;//Js//Planks Constant
e=1.6*10^-19;//C///Charge on electron
mc=0.067;//mo
mc=mc*0.91*10^-30;//kg
E0=1;//kV/cm
E0=E0*10^3/10^-2;//V/m
//Part (a)
tau_sc=10^-13;//s
v0=e*tau_sc*E0/mc;///m/s
v0=v0*100;//cm/s
disp(v0,"(a) Drift velocity(cm/s)");
```

```
//Part (b)
tau_sc=10^-12;//s
v0=e*tau_sc*E0/mc;///m/s
v0=v0*100;//cm/s
disp(v0,"(b) Drift velocity(cm/s)");
//Part (c)
tau_sc=10^-11;//s
v0=e*tau_sc*E0/mc;///m/s
v0=v0*100;//cm/s
disp(v0,"(c) Drift velocity(cm/s)");
```

Scilab code Exa 4.13 Conductivity and drift velocity

```
//Example 4_13
clc;
clear;
close;
format('v',9)
//given data :
n0=7.87*10^28;//m^-3
mu=35.2;//cm^2/vs
E0=30*10^2;//V/m
h=1.05*10^-34;//Js//Planks Constant
e=1.6*10^-19;//C///Charge on electron
//Part (a)
sigma=n0*e*mu*10^-4;//s/m
disp(sigma,"(a) Conductivity(s/m)");
//Part (b)
V0=E0*mu*10^-4;//m/s
disp(V0,"(b) Drift velocity of electron(m/s)");
J=sigma*E0;//A/m^3
disp(J,"(b) Current density(A/m^3)")
//Answer given in the textbook is not accurate.
```

Scilab code Exa 4.14 Calculate the drift velocity

```
//Example 4_14
clc;
clear;
close;
format('e',9)
//given data :
A=10^-5;//m^2
I=100;//A
n0=8.5*10^28;//m^-3
e=1.6*10^-19;//C///Charge on electron
//Formula : I=no*A*vd*e
vd=I/n0/A/e;//ms^-1
disp(vd,"Drift Velocity(ms^-1)")
```

Scilab code Exa 4.15 Calculate the drift velocity

```
//Example 4_15
clc;
clear;
close;
format('e',9)
//given data :
A=10^-5;//m^2
I=100;//A
n0=8.5*10^28;//m^-3
e=1.6*10^-19;//C///Charge on electron
//Formula : I=no*A*vd*e
vd=I/n0/A/e;//ms^-1
disp(vd,"Drift Velocity(ms^-1)")
```

Scilab code Exa 4.16 Calculate the drift velocity

```
//Example 4_16
clc;
clear;
close;
format('v',7);
//given data :
V=1;//V
L=10;//m
tau=10^-14;//s
e=1.6*10^-19;//C///Charge on electron
m=0.02*9.1*10^-31;//kg//effective mass of electron
E0=V/L;//V/m
v0=e*E0*tau/m;//m/s
disp(v0,"Drift Velocity(ms^-1)")
```

Scilab code Exa 4.17 Equilibrium hole concentration

```
//Example 4_17
clc;
clear;
close;
format('e',9);
//given data :
Nd=10^17;//atoms/cm^3
ni=1.5*10^10;//atoms/cm^3
n0=Nd;//atoms/cm^3(For Nd>>ni)
p0=ni^2/n0;//atoms/cm^3
disp(p0,"Equilibrium hole concentration(cm^-3)")
```

Scilab code Exa 4.18 Calculate the time

```
//Example 4_18
clc;
clear;
close;
format('v',6);
//given data :
h=1.05*10^-34;//Js//Planks Constant
e=1.6*10^-19;//C///Charge on electron
E0=10^4;//V/cm
a=5.62*10^-8;//cm//lattice constant for n-GaAs
kB=2*%pi/a;//cm^-1///Brillouin Edge
tau=h*kB/e/E0*10^12;//ps
disp(tau,"Time taken by electron to reach Brillouin
    Zone(ps)");
//Answer given in the textbook is wrong
```

Scilab code Exa 4.19 Estimate smallest k vector

```
//Example 4_19
clc;
clear;
close;
format('v',8);
//given data :
c=3*10^8;//m/s//Speed of light
h=1.05*10^-34;//Js//Planks Constant
mc=0.067;//mo
mc=mc*0.91*10^-30;//kg
E=0.3;//eV
E=E*1.6*10^-19;//J
```

```
//Formula//E=3*h^2*kx^2/2/mc
kx=sqrt(2*mc*E/3/h^2);//m^-1
disp(kx,"Smallest k-vector along x-direction(m^-1)")
   ;
```

Scilab code Exa 4.20 Electron and hole concentration

```
//Example 4_20
clc;
clear;
close;
format('e',9);
//given data :
ni=1.5*10^10;//cm^-3
mu_n=1350;//cm^2/V-s
mu_p=450;//cm^2/V-s
n0=ni*sqrt(mu_p/mu_n);//cm^-3
p0=ni*sqrt(mu_n/mu_p);//cm^-3
disp(n0,"Electron concentration(cm^-3)")
disp(p0,"Hole concentration(cm^-3)")
```

Scilab code Exa 4.21 Position of fermi level

```
//Example 4_21
clc;
clear;
close;
format('v',7);
//given data :
h=1.05*10^-34;//Js//Planks Constant
n0=6.02*10^23;//atom/mole
n0=n0/72.6;//atom/gram
n0=n0*5.32;//atom/cm^3
```

```
ND=1/10^7*n0;//cm^-3
T=300;//K
//mc=1/2*mo
mcBYmo=1/2;
kBT=0.026;//eV//For T=300K
Nc=ND*(mcBYmo*T)^(3/2);//cm^-3
n0=ND;//cm^-3///Considering full ionization
EF=kBT*log(n0/Nc);//eV
disp(EF,"Position of fermi level(eV)")
```

Scilab code Exa 4.22 Mobility of free electron

```
//Example 4_22
clc;
clear;
close;
format('e',8);
//given data :
e=1.6*10^-19;//C/electron
d=270;//g/cm^3
rho=3.44*10^-6;//ohm-cm
ne=3;//electrons/atom
me=26.97*1.66*10^-27
n0=d/100*ne*10^-3/me*10^6;//m^-3
mu=1/n0/e/rho*10^2;//V-sec
disp(mu,"Mobility of free electron(m^2/V-s)")
```

Scilab code Exa 4.23 Mobility of free electron

```
//Example 4_23
clc;
clear;
close;
```

```
format('v',4);
//given data :
e=1.6*10^-19;//C/electron
Eg=1.21;//eV
ne=3;//electrons/atom
dniBYni=(1.5+Eg/0.052)*(1/ne/100)*100;//% per degree
disp(dniBYni,"100*dni/ni is ( % per degree)");
```

Scilab code Exa 4.24 Drift velocity mobility and conductivity

```
//Example 4_24
clc;
clear;
close;
format('e',9);
//given data :
d=1.03;//mm
R=6.51;//ohm per 1000 ft.
n0=8.4*10^27;//electrons/m^3
I=2;//A
A=%pi/4*d^2*10^-6;//m^2
J=I/A;//A/m^2
e=1.6*10^-19;//C/electron
v0=J/n0/e;//m/s
disp(v0,"(a) Drift Velocity(m/s)");
R=R/1000/0.304;//ohm/m
E0=I*R;//V/m
mu=v0/E0;//m^2/V-s
disp(mu,"(b) Mobility(m^2/V-s)");
sigma=n0*e*mu;//(ohm-m)^-1
disp(sigma,"(c) Conductivity((ohm-m)^-1)")
//Answer wrong in the book. calculation mistake.
```

Scilab code Exa 4.25 Concentration of free electron

```
//Example 4_25
clc;
clear;
close;
format('v',9);
//given data :
T=300;//K
//Part (a)
ND=2*10^14;//cm^-3//Donor
NA=3*10^14;//cm^-3//Acceptor
ni=2.5*10^19;//m^-3//Intrinsic
ni=ni/10^6;//m^-3
n0=-(NA-ND)/2+sqrt([((NA-ND)/2)^2+ni^2]);//cm^-3
p0=-(ND-NA)/2+sqrt([((ND-NA)/2)^2+ni^2]);//cm^-3
disp(n0,"n0 is(cm^-3)");
disp(p0,"p0 is(cm^-3)");
if p0>n0 then
    disp("(a) Since p0>n0, Sample is of p-type.");
end;
//Part (b)
format('v',4);
ND=10^15;//cm^-3
NA=10^15;//cm^-3
p0=poly(0,'p0');
n0=p0+ND-NA;//cm^-3
disp(n0,"(b) n0 is equal to ");
disp("It is Intrinsic Semiconductor")
//Part (c)
disp("Part(c) : ");
format('v',7);
ND=10^16;//cm^-3
NA=10^14;//cm^-3
n0=ND;//cm^-3(For NA<<ND)
p0=ni^2/ND;//cm^-3
disp(n0,"n0 is(cm^-3)");
format('v',9);
```

```
disp(p0,"p0 is(cm^-3)");
if p0<n0 then
    disp("(c) Since p0<n0, Sample is of n-type.");
end;
```

Scilab code Exa 4.26 Concentration of holes and electron

```
//Example 4_26
clc;
clear;
close;
format('e',9);
//given data :
T=300;//K
e=1.6*10^-19;//C/electron
disp("Part(a) :");
sigma=100;//(ohm-cm)^-1
ni=2.5*10^13;//cm^-3//For Ge
mu_p=1800;//cm^2/V-s//For Ge
//sigma=p0*e*mu_p, since p0>>n0
p0=sigma/e/mu_p;//cm^-3
n0=ni^2/p0*10^6;//m^-3
disp(p0,"Concentration of holes(cm^-3)");
disp(n0,"Concentration of electrones(m^-3)");
disp("Part(b) :");
sigma=0.1;//(ohm-cm)^-1
ni=1.5*10^10;//cm^-3//For Si
mu_n=1300;//cm^2/V-s//For Si
//sigma=n0*e*mu_p, since n0>>p0
n0=sigma/e/mu_n;//cm^-3
p0=ni^2/n0*10^6;//m^-3
disp(n0,"Concentration of electrones(cm^-3)");
disp(p0,"Concentration of holes(m^-3)");
```

Scilab code Exa 4.27 Resistivity of intrinsic Ge

```
//Example 4_27
clc;
clear;
close;
format('v',5);
//data for intrinsic Ge
//n0=p0=ni;///for intrinsic
ni=2.5*10^13;//cm^-3
mu_n=3800;//cm^2/V-s
mu_p=1800;//cm^2/V-s
mu=mu_n+mu_p;//cm^2/V-s
e=1.6*10^-19;//C/electron
sigma=e*ni*(mu);//(s/cm)
rho=1/sigma;//ohm-cm
disp(rho,"Resistivity of intrinsic Ge(ohm-cm) : ");
```

Scilab code Exa 4.28 Conductivity of intrinsic Ge

```
//Example 4_28
clc;
clear;
close;
format('v',8);
//data for intrinsic Ge
//n0=p0=ni;///for intrinsic
ni=2.5*10^13;//cm^-3
mu_n=3800;//cm^2/V-s
mu_p=1800;//cm^2/V-s
mu=mu_n+mu_p;//cm^2/V-s
e=1.6*10^-19;//C/electron
```

```
sigma=e*ni*(mu);//(s/cm)
disp(sigma,"(a) Conductivity of intrinsic Ge(s/cm) :
    ");
format('v',5);
n=4.41*10^22;//cm^-3//Concentration of Ge atom
ND=n/10^7;//cm^-3
n0=ND;//cm^-3
p0=ni^2/ND;//cm^-3
sigma=n0*e*mu_n;//s/cm(n0<<p0, n0 neglected)
disp(sigma,"(b) Conductivity(s/cm)");
NA=n/10^7;//cm^-3
p0=NA;//cm^-3
n0=ni^2/NA;//cm^-3
sigma=p0*e*mu_p;//s/cm(p0<<n0, p0 neglected)
disp(sigma,"(c) Conductivity(s/cm)");
```

Chapter 5

Diode Fundamentals

Scilab code Exa 5.1 Height of potential barrier

```
//Example 5_1
clc;
clear;
close;
format('v',6);
//given data :
rho_p=1.5;//ohm-cm
rho_n=1;//ohm-cm
e=1.6*10^-19;//C/electron
//For Ge diode
mu_p=1800;//cm^2/V-s//For Ge
mu_n=3800;//cm^2/V-s//For Si
VT=0.026;///eV//at room temperature
ni=2.5*10^13;//cm^-3s
//rho=1/(NA*e*mu)
NA=1/(rho_p*e*mu_p);//cm^-3
ND=1/(rho_n*e*mu_n);//cm^-3
V0=VT*log(NA*ND/ni^2);//eV
disp(V0,"(a) Height of potential barrier(eV)");
//For Si diode
mu_p=500;//cm^2/V-s//For Ge
```

```
mu_n=1300;//cm^2/V-s//For Si
VT=0.026;///eV//at room temperature
ni=1.5*10^10;//cm^-3s
//rho=1/(NA*e*mu)
NA=1/(rho_p*e*mu_p);//cm^-3
ND=1/(rho_n*e*mu_n);//cm^-3
V0=VT*log(NA*ND/ni^2);//eV
disp(V0,"(b) Height of potential barrier(eV)");
///Answer in the texbook is not accurate.
```

Scilab code Exa 5.2 Width of depletion zone

```
//Example 5_2
clc;
clear;
close;
format('e',9);
//given data :
ND=10^16;//cm^-3
A=4*10^-4;//cm^2
NA=5*10^18;//cm^-3
T=300;//K
epsilon0=8.85*10^-14;//vaccum permittivity
epsilonr=11.8;//relative permittivity
e=1.6*10^-19;//C/electron
ni=1.5*10^10;//cm^-3
kBT=0.0259;//eV//at room temperture
V0=kBT*log(NA*ND/ni^2);//V
W=sqrt(2*epsilonr*epsilon0*V0/e*(1/NA+1/ND));//cm
disp(W,"Width of depletion zone(cm)");
///Answer in the texbook is not accurate.Calculation
    mistake in W.
```

Scilab code Exa 5.3 Thermal and barrier voltage

```
//Example 5_3
clc;
clear;
close;
format('v',5);
//given data :
ND=1.2*10^21;//cm^-3
NA=10^22;//cm^-3
T=(273+30);//K
kB=1.38*10^-23;//Boltzman constant
e=1.6*10^-19;//C/electron
VT=kB*T/e*1000;//mV//Thermal Voltage
disp(VT,"Thermal Voltage(mV)")
format('v',6);
ni=1.5*10^16;//cm^-3
V0=VT/1000*log(NA*ND/ni^2);//V
disp(V0,"Barrier Voltage(V)");
///Answer in the texbook is not accurate.
```

Scilab code Exa 5.4 Calculate the barrier potential

```
//Example 5_4
clc;
clear;
close;
format('v',5);
//given data :
t1=25;//degree C
t2=70;//degree C
VB1=0.7;//V
delV=-0.002*(t2-t1);//V
VB2=VB1+delV;//V//barrier potential
disp(VB2,"(a) Barrier potential at 70 degree C is (V
```

```
   )");
//Part (b)
t1=25;//degree C
t2=0;//degree C
VB1=0.7;//V
delV=-0.002*(t2-t1);//V
VB2=VB1+delV;//V//barrier potential
disp(VB2,"(b) Barrier potential at 0 degree C is (V)
   ");
```

Scilab code Exa 5.5 Find CT

```
//Example 5_5
clc;
clear;
close;
format('v',6);
//Part(a) Derivation
//Part(b)
//given data :
mu_p=500;//cm^2/V-s
q=1.6*10^-19;//C/electron
rho=3;//ohm-cm
V0=0.4;//V//Barrier Height
Vd=4.5;//V//Reverse Voltage
D=40;//mils
D=D*10^-3;//inch
D=D*2.54;//cm/in
A=%pi/4*D^2;//cm^2
NA=1/rho/mu_p/q;//cm^-3
W=sqrt((V0+Vd)/(14.13*10^10));//m^2
Vj=V0+Vd;//V
CT=2.9*10^-4*sqrt(NA/Vj)*A;///pF
disp(CT,"CT(pF) : ");
//Answer given in the textbook is not accurate.
```

Scilab code Exa 5.6 Compute the decrease in capacitance

```
//Example 5_6
clc;
clear;
close;
format('v',5);
//given data :
V=5;//V
CT=20;//pF
lambda=CT*sqrt(V);//pm
//increased V=V+1.5;//V
V=V+1.5;//V
CTnew=lambda/sqrt(V);//pF
dCT=CT-CTnew;//pF
disp(dCT,"Decrese in capacitance(pF)");
//Answer given in the textbook is not accurate.
```

Scilab code Exa 5.7 Calculate the barrier capacitance

```
//Example 5_7
clc;
clear;
close;
format('v',6);
//given data :
A=1.5*1.5;//mm^2
A=A/100;//cm^2
W=2*10^-4;//cm(Space charge thikness)
epsilon=16/(36*%pi*10^11);//F/cm(For Ge)
CT=epsilon*A/W*10^12;//pF
disp(CT,"Barrier capacitance(pF)");
```

Scilab code Exa 5.8 Width of depletion layer

```
//Example 5_8
clc;
clear;
close;
format('v',4);
//given data :
e=1.6*10^-19;//C/electron
NA=2.5*10^20;//atoms/m^3
epsilon=16/(36*%pi*10^9);//F/m(For Ge)
Vd=0.2;//V//Barrier height
//Part(a)
V0=10;//V(reverse bias)
W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6;//micro m
disp(W,"(a) Width of depletion layer(micro m)");
format('v',5);
//Part(b)
V0=0.1;//V(reverse bias)
W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6;//micro m
disp(W,"(b) Width of depletion layer(micro m)");
//Part(c)
V0=0.1;//V(forward bias)
W=sqrt((Vd-V0)*2*epsilon/e/NA)*10^6;//micro m
disp(W,"(c) Width of depletion layer(micro m)");
//Part(d)
A=1;//mm^2//Cross section area
A=A/10^6;//m^2
format('v',6);
//For (a)
V0=10;//V(reverse bias)
W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6;//micro m
CT=epsilon*A/(W*10^-6)*10^12;//pF
disp(CT,"(d)(a) Space Charge capacitance(pF) ");
```

```
//For (b)
V0=0.1;//V(reverse bias)
W=sqrt((V0+Vd)*2*epsilon/e/NA)*10^6;//micro m
CT=epsilon*A/(W*10^-6)*10^12;//pF
disp(CT,"(d)(b) Space Charge capacitance(pF) ");
//Answer given in the textbook is not accurate.
```

Scilab code Exa 5.10 Reverse saturation point

```
//Example 5_10
clc;
clear;
close;
format('v',6);
//given data :
sigma_p=3;//(ohm-cm)^-1
sigma_n=0.1;//(ohm-cm)^-1
Ln=0.15;//cm
Lp=0.15;//cm
e=1.6*10^-19;//C/electron
mu_p=1800;//cm^2/V-s//For Ge
mu_n=3800;//cm^2/V-s//For Si
VT=0.026;///eV//at T=27 degree C
A=1.5;//mm^2
A=A*10^-6;//m^2
b=mu_n/mu_p;//unitless
ni=2.5*10^15;//m^-3
sigma_i=(mu_n+mu_p)*ni*e;//(ohm-m)^-1
I0=A*VT*b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/
    sigma_n)*10^6;//micro A
disp(I0,"Reverse saturation point of current(micro A
    )");
```

Scilab code Exa 5.12 Reverse saturation current

```
//Example 5_12
clc;
clear;
close;
format('v',6);
//given data :
A=5;//mm^2
A=A*10^-2;//cm^2
Ln=0.01;//cm
Lp=0.01;//cm
sigma_p=0.01;//(ohm-cm)^-1
sigma_n=0.01;//(ohm-cm)^-1
mu_p=500;//cm^2/V-s//For Ge
mu_n=1300;//cm^2/V-s//For Si
e=1.6*10^-19;//C/electron
VT=0.026;///eV//at T=27 degree C
b=mu_n/mu_p;//unitless
ni=1.5*10^10;//m^-3
sigma_i=(mu_n+mu_p)*ni*e;//(ohm-m)^-1
I0=A*VT*b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/
    sigma_n)*10^12;//pA
disp(I0,"Reverse saturation current(pA)");
```

Scilab code Exa 5.13 Ratio of reverse saturation current

```
//Example 5_13
clc;
clear;
close;
format('e',9);
//given data :
Ln=0.1;//cm
Lp=0.1;//cm
```

```
e=1.6*10^-19;//C/electron
//For Si
ni=1.5*10^10;//m^-3
sigma_p=0.01;//(ohm-cm)^-1
sigma_n=0.01;//(ohm-cm)^-1
mu_n=1300;//cm^2/V-s//For Si
mu_p=500;//cm^2/V-s//For Ge
b=mu_n/mu_p;//unitless
sigma_i=(mu_n+mu_p)*ni*e;//(ohm-m)^-1
YSi=b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/sigma_n);
    //(ohm-cm^2)^-1
//For Ge
ni=2.5*10^13;//m^-3
sigma_p=1;//(ohm-cm)^-1
sigma_n=1;//(ohm-cm)^-1
mu_n=3800;//cm^2/V-s//For Si
mu_p=1800;//cm^2/V-s//For Ge
b=mu_n/mu_p;//unitless
sigma_i=(mu_n+mu_p)*ni*e;//(ohm-m)^-1
YGe=b*sigma_i^2/(1+b)^2*(1/Lp/sigma_p+1/Ln/sigma_n);
    //(ohm-cm^2)^-1
ratio=YGe/YSi;
disp(ratio,"Ratio of reverse saturation current in
    Ge to that in Si");
//Answer given in the book is not accurate.
```

Scilab code Exa 5.14 Calculate the current

```
//Example 5_14
clc;
clear;
close;
format('v',6);
//given data :
I0=9*10^-7;//A
```

```
VF=0.1;//V
I=I0*(exp(40*VF)-1)*10^6;//micro A
disp(I,"Current flowing(micro A)");
//Answer given in the book is not accurate.
```

Scilab code Exa 5.15 Find the voltage

```
//Example 5_15
clc;
clear;
close;
format('v',7);
//given data :
e=1.6*10^-19;//C/electron
J0=500;//mA/m^2
J0=J0/1000;//A/m^2
T=350;//K
Eta=1;//For Ge
k=1.38*10^-23;//Boltzman constant
J=10^5;//Am^-2
//J=J0*(exp(e*V/Eta/kT-1)
V=(1+log(J/J0))/e*Eta*k*T;//V
disp(V,"Voltage to be applied at junction(V)");
//Answer given in the book is not accurate.
```

Scilab code Exa 5.16 Find the current

```
//Example 5_16
clc;
clear;
close;
format('v',7);
//given data :
```

```
e=1.6*10^-19;//C/electron
kB=1.38*10^-23;//Boltzman constant
Is=0.15;//pA
Is=Is*10^-12;//A
V=0.55;//V(Forward Biased)
Eta=1;//Assumed
//At t=20 degee C
t=20;//degree C
T=t+273;//K
VT=kB*T/e;//V
I=Is*(exp(V/Eta/VT)-1)*1000;//mA
//At t=100 degee C
t=100;//degree C
T=t+273;//K
VT=kB*T/e;//V
//Is increased by factor 2^8
Is=Is*2^8;//A
I=Is*(exp(V/Eta/VT)-1);//A
disp(I,"Current in the diode(A)");
```

Scilab code Exa 5.17 Calculate the current and voltage

```
//Example 5_17
clc;
clear;
close;
format('v',7);
//given data :
e=1.6*10^-19;//C/electron
kB=1.38*10^-23;//Boltzman constant
Eta=2;//For Si diode
I01=2;//micro A
I02=4;//micro A
Vz1=100;//V
Vz2=100;//V
```

```
VT=0.026;//V//Thermal temperature
disp("When V=90V : ");
V=90;//V
//V<Vz1 & Vz2; Breakdown will not occur
I1=I01/2;//micro A(For D1)
disp(I1,"For D1, Current is (micro A)");
I2=-I01/2;//micro A
disp(I2,"For D2, Current is (micro A)");
V2=Eta*VT*log(1-I01/I02);//V
V1=V+V2;//V
disp(V1,"Voltage V1(V) : ");
format('v',5);
V2=V2*1000;//mV
disp(V2,"Voltage V2(mV) : ");
disp("When V=110V : ");
V=110;//V
//V>Vz1 //D1 breakdown & D2 reverse biased
I=I01;//micro A
disp(I,"Current in the circuit is (micro A)");
V1=-Vz1;///V
V2=-(V-Vz2);//V
disp(V1,"Voltage V1(V) : ");
disp(V2,"Voltage V1(V) : ");
```

Scilab code Exa 5.18 Ratio of current

```
//Example 5_18
clc;
clear;
close;
format('v',6);
//given data :
e=1.6*10^-19;//C/electron
VT=0.026;//V//Thermal Voltage
IBYI0=-90/100;//ratio
```

```
//Part (a)
//I=I0*(exp(V/VT)-1)
V=log(IBYI0+1)*VT;//V
disp(V,"(a) Required Voltage is (V)");
//Part (b)
format('v',5);
V=0.05;//V(Forward bias)
ratio=(exp(V/VT)-1)/(exp(-V/VT)-1);//ratio
disp(ratio,"(b) Current ratio");
//Part (c)
format('v',6);
I0=15;//micro A
V=[0.1 0.2 0.3]*1000;//mV
VT=VT*1000;//mV
I1=I0*(exp(V(1)/VT)-1)/1000;//mA
I2=I0*(exp(V(2)/VT)-1)/1000;//mA
I3=I0*(exp(V(3)/VT)-1)/10^6;//A
disp("(c) Current for 0.1 V is "+string(I1)+" mA,
   for 0.2 V is "+string(I2)+" mA & for 0.3 V is "+
   string(I3)+" A.");
//Answer given in the book is not accurate.
```

Scilab code Exa 5.19 Calculate the anticipated factor

```
//Example 5_19
clc;
clear;
close;
format('v',4);
//given data :
//Part (a)
t1=25;//degree C
t2=70;//degree C
I0t2BYI0t1=2^((t2-t1)/10+1);//anticipated factor
disp(I0t2BYI0t1,"(a) Anticipated factor");
```

```
disp("I0(70 degree C) = "+string(I0t2BYI0t1)+"*I0(25
    degree C)");
//Part (b)
format('v',6)
t1=25;//degree C
t2=150;//degree C
I0t2BYI0t1=2^((t2-t1)/10);//anticipated factor
disp(I0t2BYI0t1,"(b) Anticipated factor");
disp("I0(150 degree C) = "+string(I0t2BYI0t1)+"*I0
    (25 degree C)");
//Answer in the textbook is not accurate.
```

Scilab code Exa 5.20 Leakage resistance

```
//Example 5_20
clc;
clear;
close;
format('v',5);
//given data :
I=5;//micro A
V=10;//V
//1/I0*dI0/dT=0.15 & 1/I*dI0/dT=0.07
I0=I/(0.15/0.07);//micro A
//I=I0+IR
IR=I-I0;//micro A
R=V/IR;//Mohm
disp(R,"Leakage Resistance(Mohm)");
```

Scilab code Exa 5.21 Maximum reverse bias voltage

```
//Example 5_21
clc;
```

```
clear;
close;
format('v',5);
//given data :
Rt=0.15;//mW/degree C(Thermal resistance)
t1=25;//degree C
I0_t1=5;//micro A(at 25 degree C)
delt=10;//degree C
t2=t1+delt;//degree C
Pout=Rt*(t2-t1);//mW
//reverse current doubles at evry 10 degree C
I0_t2=2*I0_t1;//micro A
V=Pout/(I0_t2/1000);//V
disp(V,"Maximum reverse bias voltage(V)");
```

Scilab code Exa 5.22 Current multiplying factor

```
//Example 5_22
clc;
clear;
close;
format('v',5);
//given data :
V=0.4;//V(Forward voltage)
t1=25;//degree C
t=150;//degree C
T=t+273;//K
T1=t1+273;//K
VT=T/11600;//V
//I0T=I01*2^((T-T1)/10)
I0TBYI0T1=2^((T-T1)/10);//ratio of current
Eta=2;//for Si
I2ByI0T=(exp(V/Eta/VT)-1);//ratio of current
//At 25 degree C
VT1=T1/11600;//V
```

```
I1ByI0T1=(exp(V/Eta/VT1)-1);//A///at 25 degree C
I2ByI1=I2ByI0T/I1ByI0T1*I0TBYI0T1;///ratio of I2 & I1
disp(I2ByI1,"Current multiplying factor is ");
//Note : Solution is complete in this code.
//In the textbook, extra lines are given for which data is not given.
```

Scilab code Exa 5.24 Diffusion Length

```
//Example 5_24
clc;
clear;
close;
format('e',10);
//given data :
I=1;///mA
CD=1.5;//micro F
Eta=2;//for Si
Dp=13;//for Si
VT=0.026;//V(Thermal voltage)
Lp=sqrt(CD/10^6*Dp*Eta*VT/(I*10^-3));//m
disp(Lp,"Diffusion Length(m)");
```

Scilab code Exa 5.25 Find the static resistance

```
//Example 5_25
clc;
clear;
close;
format('v',7);
//given data :
I0=20;///micro A
```

```
VF=0.2;//V
t=27;//degree C
T=t+273;//K
VT=T/11600;//V(Thermal voltage)
Eta=1;//for Ge
I=I0*10^-6*[exp(VF/Eta/VT)-1]*1000;//mA
rdc=VT/(I0*10^-6)*exp(VF/Eta/VT)/10^6;//Mohm
disp(rdc,"Static Resistance(Mohm) : ");
//Note : Answer & Solution in the textbook is wrong as they calculated rdc for the values given in next example.
//I0 taken 80micro A instead 20 micro A & VT taken for 125 degree C instead 25 degree C.
```

Scilab code Exa 5.26 Find the dynamic resistance

```
//Example 5_26
clc;
clear;
close;
format('v',6);
//given data :
I0=80;///micro A
t=125;//degree C
T=t+273;//K
Eta=1;//for Ge
VF=0.2;//V
VT=T/11600;//V(Volt equivalent of temperature)
///Part(a) In forward direction
Rac=VT/(I0*10^-6)*exp(-VF/Eta/VT);//ohm
disp(Rac,"(a) Dynamic Resistance in forward diection (ohm) :  ");
///Part(b) In reverse direction
format('v',8);
Rac=VT/(I0*10^-6)*exp(VF/Eta/VT)/10^6;//Mohm
```

```
disp(Rac,"(b) Dynamic Resistance in reverse diection (Mohm) :  ");
//Answer in the textbook is not accurate.
```

Scilab code Exa 5.27 Determine ac resistance

```
//Example 5_27
clc;
clear;
close;
format('v',7);
//given data :
I0=1.5;///micro A
T=300;//K
VF=150;//mV
kB=8.62*10^-5;//Boltzman Constant
VT=T/11600;//V(Volt equivalent of temperature)
rac=1/(I0*10^-6/kB/T*exp(VF/1000/VT));
disp(rac,"Ac resistance(ohm)")
//Answer and unit in the textbok is wrong.
```

Scilab code Exa 5.28 Maximum allowable current

```
//Example 5_28
clc;
clear;
close;
format('v',5);
//given data :
Pmax=2.5;//W
Vf=900;//mV
If_max=Pmax/(Vf/1000);//A
```

```
disp(If_max,"(a) Maximum allowable forward current(A
   ) : ");
Rf=Pmax/If_max^2;//ohm
format('v',7);
disp(Rf,"(b) Forward Diode Resistance(ohm)")
//Answer in the textbok is wrong.
```

Scilab code Exa 5.29 Height of potential barrier

```
//Example 5_29
clc;
clear;
close;
format('v',5);
//given data :
//for Ge diode
rho_p=2;//ohm-cm(p-side resistivity)
rho_n=1;//ohm-cm(n-side resistivity)
e=1.6*10^-19;//C/electron
mu_p=1800;//m^2/V-s
mu_n=3800;//m^2/V-s
VT=0.026;//V(Thermal Voltage)
ni=2.5*10^13;//per cm^3(intrinsic concentration)
NA=1/(rho_p*e*mu_p);//per cm^3
ND=1/(rho_n*e*mu_n);//per cm^3
V0=VT*log(ND*NA/ni^2);//eV
disp(V0,"(a) Height of potential barrier(eV) : ");
//for Si diode
format('v',6);
mu_p=500;//m^2/V-s
mu_n=1300;//m^2/V-s
ni=1.5*10^10;//per cm^3(intrinsic concentration)
NA=1/(rho_p*e*mu_p);//per cm^3
ND=1/(rho_n*e*mu_n);//per cm^3
V0=VT*log(ND*NA/ni^2);//eV
```

```
disp(V0,"(b) Height of potential barrier(eV) : ");
```

Scilab code Exa 5.30 Find the dynamic resistance

```
//Example 5_30
clc;
clear;
close;
format('v',6);
//given data :
t=125;//degree C
T=t+273;//K
Eta=1;//for Ge
VF=0.2;//V
VT=T/11600;//V(Volt equivalent of temperature)
I0=35;//micro A
//Part(a) Forward Direction
r=VT/(I0*10^-6)/exp(VF/VT);//ohm
disp(r,"(a) Dynamic Resistance in forward direcion(
    ohm) : ");
//Part(b) Reverse Direction
r=VT/(I0*10^-6)/exp(-VF/VT);//ohm
r=r/10^6;//Mohm
disp(r,"(b) Dynamic Resistance in reverse direcion(
    Mohm) : ");
///Answer in the textbook is not accurate.
```

Scilab code Exa 5.31 Maximum and minimum zener current

```
//Example 5_31
clc;
clear;
close;
```

```
format('v',6);
//given data :
Vz=10;//V
Rs=1;//kohm
RL=10;//kohm
IL=5;//mA(Assumed)
Vi=25:40;//V
RLmin=Rs;//kohm
Iz=(max(Vi)-Vz)/RLmin-IL;//mA
disp(Iz,"(a) Maximum value of zener current(mA) : ");
Iz_min=(min(Vi)-Vz)/Rs-IL;//mA
disp(Iz_min,"(b) Minimum value of zener current(mA) : ");
```

Scilab code Exa 5.32 Find the range of R

```
//Example 5_32
clc;
clear;
close;
format('v',6);
//given data :
Vz=5;//V
Pmax=250;//mW
Vs=15;//V(Supply voltage)
PL=50;//W(Load)
Imax=Pmax/Vz;//mA(Maximum permissible current)
//Minimum current to maintain constant voltage
Imin=Imax-Imax*10/100;//mA
Rmin=Vs/Imax;//kohm
Rmax=Vs/Imin;//kohm
disp("For maintainng constant voltage, Range of R is "+string(Rmin)+" kohm to "+string(Rmax)+" kohm.");
```

```
//Diode loaded with 50W load
Imax=PL/Vz;//mA(Maximum permissible current)
//Minimum current to maintain constant voltage
Imin=Imax-Imax*10/100;//mA
Rmin=Vs/Imax;//kohm
Rmax=Vs/Imin;//kohm
disp("New range of R is "+string(Rmin)+" kohm to "+
    string(Rmax)+" kohm.");
//Solution is not complete in the textbook.
```

Scilab code Exa 5.33 Find out breakdown voltage

```
//Example 5_33
clc;
clear;
close;
format('v',6);
//given data :
ND=2*10^15;//cm^-3
Ep=1.5*10^5;//V/cm
epsilon=8.854*10^-14;//Permittivity
e=1.6*10^-19;//C/electron
//Width of depletion region
W=Ep*11.9*epsilon/e/ND;
VBR=W*Ep/2;//V
disp(VBR,"Breakdown Voltage(V) : ");
```

Scilab code Exa 5.35 Breakdown Voltage

```
//Example 5_35
clc;
clear;
close;
```

```
format('v',4);
//given data :
Ez=2*10^7;///V/m
//Vz=epsilon*Ez^2/(2*e*NA)
//e*NA=sigp/mu_p; as sigp=NA*e*mu_p
epsilon=16/(36*%pi*10^9);//F/m
mu_p=1800;//cm^2/V-s
sigp=poly(0,'sigp');//Notation : sigp=sigma_p
Vz=epsilon*Ez^2/2*mu_p*10^-6/sigp;//V
disp(Vz,"(a) Breakdown Voltage calculated and proved as ");
format('v',6);
sigma_i=1/45;//(ohm-cm)^-1
sigma_p=sigma_i;//(ohm-cm)^-1//as p-material is intrinsic
Vz=51/sigma_p;//V
disp(Vz,"(b) Vz(V) : ");
sigma_p=1/3.9;//(ohm-cm)^-1
Vz=51/sigma_p;//V
disp(Vz,"(c) Vz(V) : ");
//Part (d)
Vz=1.5;///V
sigma_p=51/Vz;//V
disp(sigma_p,"(d) Resistivity(ohm-cm)^-1 : ");
//Note : Part(b) answer wrong in the book & part(d) not complete.
//Note : sigp is used instead sigma_p as poly support only less than 5 character.
```

Scilab code Exa 5.36 Voltage across junction

```
//Example 5_36
clc;
clear;
close;
```

```
format('v',5);
//given data :
Eta=1;//for Ge
T=300;//K
VT=0.026;//V(Thermal Voltage)
VF=5;///V
//I=I0;///given
IByI0=1;//ratio
//Using I=I0*(exp(V/VT)-1)
V=log(IByI0+1)*VT;//V
V2=VF-V;//V(Voltage across 2nd diode)
disp(V2,"(a) Voltage across each junction(V) : ");
//Part (b)
format('v',6);
Vz=4.9;//V
Vrb=Vz;//V(Across reverse biased diode)
V2=VF-Vrb;//V
I0=6;//micro A
I=I0*(exp(V2/VT)-1);//micro A
disp(I,"(b) Current in the circuit(micro A) : ");
//Note : Answer in the textbook is not accurate.
```

Scilab code Exa 5.37 Find out ideality factor

```
//Example 5_37
clc;
clear;
close;
format('v',5);
//given data :
I1=0.5;//mA
V1=340;//mV
I2=15;//mA
V2=465;//mV
kBTBye=25;//mV(It is kB*T/e)
```

```
//I=Is*(exp(V/Eta/kBTBye)-1)
Eta=(V2/kBTBye-V1/kBTBye)/log(I2/I1);//neglecting 1 as exp(V/Eta/kBTBye)>>1
disp(Eta,"Ideality Factor(Eta) : ");
```

Scilab code Exa 5.38 Temperature coefficient

```
//Example 5_38
clc;
clear;
close;
format('v',7);
//given data :
Vd=12;//V
TC1=-1.7;//mV/degree C(Temperatre Coefficient of Si diode)
//For series combination to have TC=0
TC2=-TC1;//mV/degree C(Temperatre Coefficient of Avalanche diode)
//In percentage
TC2=TC2*10^-3/Vd*100;//%/degree C
disp(TC2,"Required temperature coefficient(%/degree C) : ");
```

Scilab code Exa 5.39 Calculate R

```
//Example 5_39
clc;
clear;
close;
format('v',6);
//given data :
//For IL=0;//A
```

```
V0=60;//V
V=200;//V(Supply Voltage)
ID=5:40;//mA
R=(V-V0)/max(ID);//kohm(R is >= this value)
//For IL=ILmax;//A
IT=max(ID);//mA
ID=min(ID)///mA(ID<=this value)
Imax=IT-ID;///mA
disp(Imax,"(a) Imax(mA) : ");
//Part (b)
IL=25;//mA
ID=5:40;//mA
//Taking minimum current for good regulation
IT=min(ID)+IL;///mA
Vmax1=IT*R+V0;//V
//Taking maximum current for good regulation
IT=max(ID)+IL;///mA
Vmax2=IT*R+V0;//V
disp("(b) Without loss of regulation, V may vary
    from "+string(Vmax1)+" V to "+string(Vmax2)+" V."
    );
```

Chapter 6

Diode Circuits

Scilab code Exa 6.1 Find the current

```
//Example 6_1
clc;
clear;
close;
format('v',5);
//given data :
I0=10;//micro A
Vz=100;//V
R=1.5;//kohm
V=45;//V
///Part(a)
I=V/R;//mA(neglecting diode threshold voltage)
//I=I0*(exp(38.4*V)-1)//Diode Current Equation
Vd=(log(I*10^-3/(I0*10^-6)+1))/38.4;//V(Diode
    Voltage)
//Now calculating I again
I=(V-Vd)/R;//mA
disp(I,"(a) If diode is forward biased, Current(mA)"
    );
//Part(b)
Vd=-V;//V(for reverse polarity of battery)
```

```
I=-I0;//micro A
//Voltage drop across resistor neglected
disp(I,"(b) If battery inserted with reverse
    polarity , Current(micro A)");
//Part(c)
Vz=10;//V
//in forward direction behaviour will remain same
I=V/R;//mA(neglecting diode threshold voltage)
//I=I0*(exp(38.4*V)-1)//Diode Current Equation
Vd=(log(I*10^-3/(I0*10^-6)+1))/38.4;//V(Diode
    Voltage)
//Now calculating I again
I=(V-Vd)/R;//mA
disp(I,"(c) If diode is forward biased , Current(mA)"
    );
//reverse direction
//load line dataV=30;//
V=30;//V
I=-30;//mA
V1=20;//V//from Load Line
Idash=I*V1/V;///A
disp(Idash,"(c) If battery inserted with reverse
    polarity , Current(mA)");
//Answer in the book is not accurate ,
```

Scilab code Exa 6.2 Find the current

```
//Example 6_2
clc;
clear;
close;
format('v',5);
//given data :
V=100;//V
//For diode D1
```

```
V1gamma=0.2;//V
r1=20;//ohm
//For diode D2
V2gamma=0.6;//V
r2=15;//ohm
//Part(a)
//Assume D1 & D2 are ON
R=10;//kohm
//Writing loop equations
//V=(R+r1/1000)*I1+R*I2+V1gamma;(eqn(1))
A1=[(R+r1/1000) R];//Coefficient matrix
B1=[V-V1gamma];//Coefficient matrix
//V=(R+r2/1000)*I2+R*I1+V2gamma;(eqn(2))
A2=[R (R+r2/1000)];//Coefficient matrix
B2=[V-V2gamma];//Coefficient matrix
A=[A1;A2];//Coefficient matrix
B=[B1;B2];//Coefficient matrix
X=A^-1*B;//solution matrix
I1=X(1);///mA
I2=X(2);///mA
if I2<0 then
    disp("I2<0, Assumption D2 is ON, not valid.")
//Assume D1 is ON & D2 is OFF
I2=0;//A
I1=(V-V1gamma)/(R+r1/1000);//mA
disp(I2,I1,"(a) Diode current I1 & I2 in mA are : ");
end;
//Part(b)
format('v',7);
//Assume D1 & D2 are ON
R=1.5;//kohm
//Writing loop equations
//V=(R+r1/1000)*I1+R*I2+V1gamma;(eqn(1))
A1=[(R+r1/1000) R];//Coefficient matrix
B1=[V-V1gamma];//Coefficient matrix
//V=(R+r2/1000)*I2+R*I1+V2gamma;(eqn(2))
A2=[R (R+r2/1000)];//Coefficient matrix
```

```
B2=[V-V2gamma];//Coefficient matrix
A=[A1;A2];//Coefficient matrix
B=[B1;B2];//Coefficient matrix
X=A^-1*B;//solution matrix
I1=X(1);///mA
I2=X(2);///mA
disp(I2,I1,"(b) Diode current I1 & I2 in mA are : ")
    ;
```

Scilab code Exa 6.3 Calculate the break region

```
//Example 6_3
clc;
clear;
close;
format('v',5);
//given data :
r1BYr2=10000;//multipying factor
//r=Eta*VT/I0*eps^(-V/Eta/VT)
//log(r1BYr2)=(-V1/Eta/VT)/(-V2/Eta/VT)=delV/Eta/VT
VT=26;//mV
Eta=2;//for silicon
delV=log(r1BYr2)*Eta*VT;
disp(delV,"Break region for Si(mV)");
Eta=1;//for Germenium
delV=log(r1BYr2)*Eta*VT;
disp(delV,"Break region for Ge(mV)");
//Answer in the book is not accurate.
```

Scilab code Exa 6.4 Peak and dc load current

```
//Example 6_4
clc;
```

```
clear;
close;
format('v',6);
//given data :
Rf=30;//ohm
RL=990;//ohm
Vrms=110;//V
//Part (a)
Vm=Vrms*sqrt(2);//V
Im=Vm/(Rf+RL)*1000;///mA
disp(Im,"(a) Peak Load Current(mA)");
//Part (b)
format('v',5);
Idc=Im/%pi;//mA
disp(Idc,"(b) The dc Load Current(mA)");
//Part (c)
Irms=Im/2;//mA
disp(Irms,"(c) The ac Load Current(mA)");
//Part (d)
format('v',4);
Vdc=-Im*RL/1000/%pi;//mA
disp(Vdc,"(d) The dc diode Voltage(mV)");
//Part (e)
format('v',5);
Pi=(Irms*10^-3)^2*(Rf+RL);//W
disp(Pi,"(e) Total Input Power(W)");
//Part (f)
format('v',6);
VNL=Vm/%pi;//V
VFL=Idc*RL/1000;//V
Reg=(VNL-VFL)/VFL*100;//%(Regulation)
disp(Reg,"(f) % Regulation(%)");
//Answer not accurate in the book & unit of answer for part(d) is wrong.
```

Scilab code Exa 6.8 dc load current and power

```
//Example 6_8
clc;
clear;
close;
format('v',5);
//given data :
Rf=500;//ohm
RL=2000;//ohm
Vrms=280;//V
Vm=Vrms*sqrt(2);//V
//Part (a)
Idc=2*Vm/%pi/(Rf+RL);//A
Idc=Idc*1000;//mA
disp(Idc,"(a) The dc load current(mA) : ");
//Part (b)
Idc_tube=Idc/2;///mA
disp(Idc_tube,"(b) Direct current in each tube(mA) : ");
//Part (c)
v2=Vm*Rf/(Rf+RL);//V
v1=-2*Vm+v2;//V
Vrms=sqrt(1/2/%pi*integrate('v2^2*(sin(alfa))^2','alfa',0,%pi)+1/2/%pi*integrate('v1^2*(sin(alfa))^2','alfa',%pi,2*%pi));//V
Vrms=floor(Vrms);///V
disp(Vrms,"(c) The ac voltage across each diode(V) : ");
//Part (d)
Pdc=(Idc/1000)^2*RL;//W
disp(Pdc,"(d) The dc output power(W) : ");
//Part(e)
Reg=Rf/RL*100;//%
disp(Reg,"(e) % Regulation : ");
//Answer in the textbook is not accurate.
```

Scilab code Exa 6.10 Full scale reading

```
//Example 6_10
clc;
clear;
close;
format('v',4);
Rm=20;//ohm(meter resistance)
Rs=5;//kohm(series resistance)
Im=1;///mA
Idc=2*Im/%pi;//mA
RL=Rm+Rs*1000;//ohm
Vm=Idc/1000*%pi*RL/2;///V
v0_max=2*sqrt(2)*Vm;//V
disp(v0_max,"Full scale reading(V) : ");
```

Scilab code Exa 6.11 dc output voltage and PIV

```
//Example 6_11
clc;
clear;
close;
format('v',5);
//given data :
V1=220;//V
N1ByN2=10/1;//turns ratio
V2=V1/N1ByN2;//V
Vm=sqrt(2)*V2;//V
Vdc=0.318*Vm;//V
disp(Vdc,"(a) dc output voltage(V) : " );
format('v',6);
PIV=Vm;//V
```

```
disp(PIV,"(b) PIV(V) : " );
```

Scilab code Exa 6.12 Maximum and average Power

```
//Example 6_12
clc;
clear;
close;
format('v',6);
//given data :
V1=230;//V
N2ByN1=1/3;//turns ratio
RL=200;//ohm
V2=V1*N2ByN1;//V
Vm=sqrt(2)*V2;//V
Im=Vm/RL;//A
Pmax=Im^2*RL;//W
disp(Pmax,"Maximum load power(W) : ");
format('v',5);
Vdc=0.318*Vm;//V
Idc=Vdc/RL;//A
Pdc=Idc^2*RL;//W
disp(Pdc,"Average value of load power(W) : ");
//Answer in the textbook is not accurate.
```

Scilab code Exa 6.13 Maximum value of voltage

```
//Example 6_13
clc;
clear;
close;
format('v',6);
//given data :
```

```
Vdc=30;//V
rf=25;//ohm
RL=500;//ohm
Idc=Vdc/RL;//A
Im=%pi*Idc;//A
Vi_max=Im^2*(rf+RL);//V
disp(Vi_max,"Voltage required at input(V) : ");
//Answer in the textbook is not accurate.
```

Scilab code Exa 6.14 AC voltage and efficiency

```
//Example 6_14
clc;
clear;
close;
format('v',7);
//given data :
Vdc=100;//V
rf=20;//ohm
RL=500;//ohm
Idc=Vdc/RL;//A
Im=%pi*Idc;//A
Vm=Im*(RL+rf);//V
disp(Vm,"(a) The ac voltage required(V) : ");
format('v',5);
Eta=0.406/(1+rf/RL)*100;//%(Rectification Efficiency
    )
disp(Eta,"Rectification Efficiency(%) : ");
```

Scilab code Exa 6.15 dc output voltage

```
//Example 6_15
clc;
```

```
clear;
close;
format('v',4);
//given data :
//v=50*sin(100*%pi*t)
Vm=50;//V
f=50;//Hz
rf=20;//ohm
RL=5000;//ohm
Im=Vm/(rf+RL)*1000;//mA
disp("(a) Current is "+string(Im)+"*sin(100*%pi*t) for %pi <100*%pi*t<2*%pi & it will be zero for 0 <100*%pi*t<%pi");
format('v',5);
Vdc=Im/1000/%pi*RL;//V
disp("(b) Output Voltage, Vo = "+string(Vdc)+"*sin(100*%pi*t) for %pi <100*%pi*t<2*%pi & it will be zero for 0 <100*%pi*t<%pi ");
//Assuming diode is ideal
disp("(c) Voltage across diode, v = "+string(Vdc)+"*sin(100*%pi*t) for 0 <100*%pi*t<%pi & it will be zero for %pi <100*%pi*t<2*%pi ");
```

Scilab code Exa 6.16 Value of capacitance

```
//Example 6_16
clc;
clear;
close;
format('v',5);
//given data :
Vrms=230;//V
f=50;//Hz
Gamma=0:0.001:0.005;//Ripple factor(Gamma<=0.005)
IL=0.5;//A
```

```
Gamma=Gamma(4);//Taken for the solution
Vm=sqrt(2)*Vrms;//V
Vdc=Vm/%pi;//V
Idc=IL;//A
RL=Vdc/Idc;//ohm
C=1/(2*sqrt(3)*f*RL*Gamma)*1000;//mF
disp(C,"Value of capacitance(mF) : ");
//Answer in the textbook is not accurate.
```

Scilab code Exa 6.17 calculate ripple factor

```
//Example 6_17
clc;
clear;
close;
format('v',5);
//given data :
RL=3.15;//kohm
rf=20;//ohm
//v=230*sin(314*t)
Vm=230;//V
f=50;//Hz
Irms=0.707*Vm/(rf+RL*1000);//A
Im=Vm/(rf+RL*1000);//A
Idc=0.637*Im
Gamma=sqrt((Irms/Idc)^2-1);//Ripple factor
disp(Gamma,"Ripple factor : ");
```

Scilab code Exa 6.18 dc output voltage and frequency

```
//Example 6_18
clc;
clear;
```

```
close;
format('v',4);
//given data :
Vp=230;//V
fin=50;//Hz
RL=200;//ohm
NsByNp=1/4;//turns ratio
Vs=Vp*NsByNp;//V
Vrms=Vs;//V
Vm=Vrms*sqrt(2);//V
Idc=2*Vm/%pi/RL;//A
RL=150;//ohm
Vdc=Idc*RL;//V
disp(Vdc,"dc output Voltage(V) : ");
//Because of two output pulses
fout=2*fin;///Hz
disp(fout,"Pulse frequency of the output(Hz) : ");
```

Scilab code Exa 6.19 Maximum dc voltage

```
//Example 6_19
clc;
clear;
close;
format('v',5);
//given data :
Vp=220;//V
fi=50;//Hz
RL=1.5;//kohm
Np=1000;//turns
Ns=100;//turns
Vs=Vp*Ns/Np;//V
Vrms=Vs*sqrt(2);//V
Vm=Vrms/2;//V(Across half secondary winding)
Idc=2*Vm/%pi/(RL*1000);//A
```

```
Vdc=Idc*RL*1000;//V
disp(Vdc,"dc output Voltage(V) : ");
//Answer in the textbook is not accurate.
```

Scilab code Exa 6.20 Calculate input voltage

```
//Example 6_20
clc;
clear;
close;
format('v',5);
//given data :
Vdc=30;//V
RL=1;//kohm
Gamma=0.015;//Ripple factor
Idc=Vdc/RL;//mA
C=2900/Gamma/(RL*1000);//micro F
disp(C,"Filter capacitor(micro F) : ");
format('v',6);
Vm=Vdc+5000*Idc/1000/C;///V
V2=2*Vm/sqrt(2);//V
disp(V2,"Required intput Voltage(V) : ");
//Answer in the textbook is not accurate.
```

Scilab code Exa 6.21 Inductance and output voltage

```
//Example 6_21
clc;
clear;
close;
format('v',5);
//given data :
IL=0.1;//A
```

```
C=40;///micro F
R=40;//ohm
Vrms=40;//V
Gamma=0.0001;//Ripple factor
n=2;//For 2 stage filter
L=1.76/C*(0.472/Gamma)^(1/n);//H
disp(L,"(a) Value of inductance(H) : ");
Vdc=2*sqrt(2)*Vrms/%pi-IL*R;//V
disp(Vdc,"(b) Output Voltage(V) : " );
```

Scilab code Exa 6.22 dc output voltage and ripple voltage

```
//Example 6_22
clc;
clear;
close;
format('v',7);
//given data :
IL=50;//micro A
C=4;///micro F
C1=4;///micro F
L=20;///H(Choke Inductance)
R=200;//ohm(Choke Resistance)
V=300;//V
Idc=IL/1000;//mA
Vdc=V*sqrt(2)-4170*Idc/C-Idc*R;//V
disp(Vdc,"Output Voltage(V) : " );
r=3300*Idc/C/C1/L/R;//Ripple factor
Vrms=r*Vdc;//V
disp(Vrms,"Ripple Voltage(V) : ");
//Answer in the textbook is wrong. calculation &
   value putting mistake.
```

Chapter 7

BJT Fundamentals

Scilab code Exa 7.1 Base and collector current

```
//Ex_7_1
clc;
clear;
close;
//given data :
format('v',6);
alfa=0.90;//current gain
ICO=15;//micro A(reverse saturation currenrt)
IE=4;//mA(Emitter currenrt)
IC=ICO*10^-3+alfa*IE;//mA
IB=IE-IC;//mA
IB=IB*1000;//micro A
disp(IC,"Collector Current(mA)");
disp(IB,"Base Current(micro A)");
```

Scilab code Exa 7.2 Value f alfa

```
//Ex_7_2
```

```
clc;
clear;
close;
//given data :
format('v',6);
Beta=90;//unitless
IC=4;//mA(Collector Current)
alfa=Beta/(1+Beta);//current gain
IB=IC/Beta;//mA(Base Current)
IE=IC+IB;//mA(Emitter currenrt)
disp(alfa,"Value of alfa");
disp(IB*1000,"Base Current(micro A)");
disp(IE,"Emmiter Current(mA)");
```

Scilab code Exa 7.3 Calculate the collector current

```
//Ex_7_3
clc;
clear;
close;
format('v',6);
//given data :
alfa=0.90;//current gain
ICO=15;//micro A(reverse saturation currenrt)
IB=0.5;///mA(Base Current)
Beta=alfa/(1-alfa);//unitless
IC=Beta*IB+(1+Beta)*ICO/1000;//mA(Collector Current)
disp(IC,"Collector Current(mA)");
```

Scilab code Exa 7.4 Value of Beta

```
//Ex_7_4
clc;
```

```
clear;
close;
format('v',6);
//given data :
IB=20;///micro A(Base Current)
IC=5;//mA(Collector Current)
Beta=IC*1000/IB;//unitless
disp(Beta,"Beta=");
```

Scilab code Exa 7.5 Value of IE

```
//Ex_7_5
clc;
clear;
close;
format('v',6);
//given data :
IB=50;///micro A(Base Current)
IC=5;//mA(Collector Current)
IE=IC+IB/1000;//mA
Beta=IC*1000/IB;//unitless
alfa=IC/IE;//current gain
disp(IE,"Emitter Current(mA)");
disp(Beta,"Beta=");
disp(alfa,"alfa=");
disp("Verify that alfa=Beta/(Beta+1)");
disp(string(alfa==Beta/(Beta+1)));
disp("Verify that Beta=alfa/(1-alfa)");
disp(string(Beta==round(alfa/(1-alfa))));
```

Scilab code Exa 7.6 Value of alfa and beta

```
//Ex_7_6
```

```
clc;
clear;
close;
format('v',6);
//given data :
IE=10;//mA
IB=5;///mA(Base Current)
IC=IE-IB;//mA(Collector Current)
BetaR=IC/IB;//unitless
alfaR=IC/IE;//current gain
disp(BetaR,"BetaR=");
disp(alfaR,"alfaR=");
//Answer is wrong in the book.
```

Scilab code Exa 7.7 Find current and voltage

```
//Ex_7_7
clc;
clear;
close;
format('v',6);
//given data :
Beta=100;//unitless
VBE=0.7;//V
VCC=10;//V
//(a) VE=-0.7;//V
disp("For the circuit in fig(a)");
VE=-0.7;//V(Constant voltage)
R1=10;//kohm
R2=10;//kohm
IE=(VCC+VE)/R2;//mA
IB=IE/(Beta+1);//mA
VC=VCC-R1*1000*(IE-IB)/1000;//V
disp(VE,"Constant voltage fo the given transistor,
    VE(V)");
```

```
disp(IE,"Emitter current(mA)");
format('v',5);
IB=IB*1000;///micro A
disp(IB,"Base current(micro A)");
format('v',6);
disp(VC,"VC(V)");

//(b) VE=-0.7;//V
R1=5;//kohm
R2=5;//kohm
VEE=-15;//V
disp("For the circuit in fig(b)");
VE=-0.7;//V(Constant voltage)
R1=5;//kohm
R2=5;//kohm
IE=(VCC+VE)/R2;//mA
IC=IE*Beta/(Beta+1);//mA
VC=VEE+R2*IC;//V
disp(VE,"Constant voltage fo the given transistor,
    VE(V)");
disp(IE,"Emitter current(mA)");
disp(IC,"Base current(mA)");
format('v',5);
disp(VC,"VC(V)");
```

Scilab code Exa 7.8 Find the voltage

```
//Ex_7_8
clc;
clear;
close;
format('v',6);
//given data :
Beta=%inf;//Current gain
VBE=0.7;////V
```

```
VB=0;//V(For large Beta)
VE=VB-VBE;////V
disp(VE,VB,"(a) Value of VB(V) & VE(V) are : ");
//Part (b)
R1=5;///kohm
R2=5;///kohm
VCC=10;///V
VEE=-15;///V
VE=VBE;////V
VC=VEE+R1/R2*(VCC-VBE);//V
disp(VC,VE,"(b) Value of VE(V) & VC(V) are : ");
```

Scilab code Exa 7.9 Find VB IB IE IC

```
//Ex_7_9
clc;
clear;
close;
format('v',6);
//given data :
VEE=5;////V
VCC=-5;////V
VE=1;////V
RB=20;//kohm
RE=5;//kohm
RC=5;//kohm
VBE=0.7;////V
VB=VE-VBE;///V
IB=VB/RB;///mA
IE=(VEE-VE)/RE;//mA
IC=IE-IB;//mA
VC=VCC+IC*RC;//V
Beta=IC/IB;//Current gain
Alfa=IC/IE;//Current gain
disp(VB,"VB(V) : ");
```

```
disp(IB,"IB(mA) : ");
disp(IE,"IE(mA) : ");
disp(IC,"IC(mA) : ");
format('v',5);
disp(Beta,"Beta : ");
disp(Alfa,"Alfa : ");
```

Scilab code Exa 7.10 Voltage changes

```
//Ex_7_10
clc;
clear;
close;
format('v',6);
//given data :
delVB=0.4;//V
delVC=0;//V//No change
delVE=delVB;//V//Same change
disp(delVC,delVE,"delVE(V) & delVC(V) are : ");
```

Scilab code Exa 7.11 Emitter Voltage

```
//Ex_7_11
clc;
clear;
close;
format('v',6);
//given data :
VBE=0.7;////V
Beta=100;///Current Gain
//Part (a)
VCC=6;////V
VEE=0;////V
```

```
VB=2;////V
RE=18;//kohm
RC=3;//kohm
VE=VB-VBE;//V
disp(VE,"(a) Emitter Voltage(V) : ");
IE=1;///mA
IC=IE*Beta/(1+Beta);///mA
VC=VCC-IC*RC;//V
if VC>VE then
    disp("Circuit is in active mode.");
end;
//Part (b)
VEE=6;////V
VCC=0;////V
VB=1;////V
RE=10;//kohm
RC=10;//kohm
VE=VB+VBE;//V
disp(VE,"(b) Emitter Voltage(V) : ");
IE=(VEE-VE)/RE;///mA
IC=IE;///mA(Assumed nearly equal)
VC=VCC+IC*RC;//V
if VC>VB then
    disp("Circuit is in saturation mode.");
end;
//Part (c)
VEE=9.5;////V
VCC=-50;////V
VB=-5;////V
RE=200;//kohm
RC=20;//kohm
VE=VB+VBE;//V
disp(VE,"(c) Emitter Voltage(V) : ");
IE=(VEE-VE)/RE;///mA;///mA
IC=IE*Beta/(1+Beta);///mA
VC=VCC-IC*RC;//V
if VC>VE then
    disp("Circuit is in active mode.");
```

```
elseif VC<VE
    disp("Circuit is in reverse active mode.")
end;
//Part (d)
VEE=-30;////V
VCC=-10;////V
VB=-20;////V
RE=6;//kohm
RC=2;//kohm
VE=VB-VBE;//V
disp(VE,"(d) Emitter Voltage(V) : ");
IE=(VEE-VE)/RE;///mA;///mA
IC=IE*Beta/(1+Beta);///mA
VC=VCC-IC*RC;//V
if VC>VE then
    disp("Circuit is in active mode.");
end;
//Note : Printing error in part (a) in the textbook.
    Answer is also not accurate in the textbook for
    part(c)
```

Chapter 8

BJT Circuits

Scilab code Exa 8.1 Calculate IB IC VCE

```
//Ex_8_1
clc;
clear;
close;
format('v',6);
//given data :
Beta=100;//unitless
Rc=2;//kohm
Rb=100;//kohm
Vcc=10;//V
VBE=0.7;//V
//Part (a)
IB=(Vcc-VBE)/(Beta*Rc+Rc+Rb);//mA
disp(IB,"IB(mA)");
format('v',4);
IC=Beta*IB;//mA
disp(IC,"IC(mA)");
format('v',5);
VCE=Vcc-(IB+IC)*Rc;//V
disp(VCE,"VCE(V)");
//Part (b)
```

```
format('v',8);
VCE=7;//V
ICB=(Vcc-VCE)/Rc;//mA(ICB=IC+IB)
IB=ICB/(1+Beta);//mA
IC=ICB*Beta;//mA
Rb=(Vcc-VBE-Rc*ICB)/IB;//kohm
disp(Rb,"Value of Rb(kohm)");
```

Scilab code Exa 8.4 Find Re R1 and R2

```
//Ex_8_4
clc;
clear;
close;
format('v',6);
//given data :
Beta=50;//unitless
VBE=0.7;//V
VCC=22.5;//V
Rc=5.6;//kohm
VCE=12;//V
IC=1.5;//mA
S=3;//Stability factor(S<=3)
Rec=(VCC-VCE)/IC;//kohm(Rec=Re+Rc)
Re=Rec-Rc;//kohm
RbBYRe=(S-1)/(1-S/(1+Beta))
Rb=RbBYRe*Re;//kohm
IB=IC/Beta;//mA
V=IB*Rb+VBE+(IB/1000+IC)*Re;//V
R1=Rb*VCC/V;//kohm
R2=R1*V/(VCC-V);//kohm
disp(Re,"Value of Re(kohm)");
disp(R1,"Value of R1(kohm)");
disp(R2,"Value of R2(kohm)");
//Answer in the book is wrong for R1.
```

Scilab code Exa 8.5 Find R1 R2 Re

```
//Ex_8_5
clc;
clear;
close;
format('v',6);
//given data :
VCC=20;//V
Rc=1.5;//kohm
VCE=8;//V
IC=4;//mA
Beta=50;//unitless\
VBE=0.2;//V
disp("Part (a)");
S=12;//Stability factor
IB=IC/Beta;//mA
Re=(VCC-VCE-IC*Rc)/(IB+IC);//kohm
RbBYRe=(S-1)/(1-S/(1+Beta))
Rb=RbBYRe*Re;//kohm
IE=IB+IC;//mA
VBN=VBE+IE*Re;//V
V=VBN+IB*Rb;//V
R1=Rb*VCC/V;//kohm
IR1=(VCC-VBN)/R1;//mA
IR2=IR1-IB;//mA
R2=VBN/IR2;//kohm
disp(R1,"Value of R1(kohm)");
disp(R2,"Value of R2(kohm)");
disp(Re,"Value of Re(kohm)");
disp("Part (b)");
S=3;//Stability factor
IB=IC/Beta;//mA
Re=(VCC-VCE-IC*Rc)/(IB+IC);//kohm
```

```
RbBYRe=(S-1)/(1-S/(1+Beta))
Rb=RbBYRe*Re;//kohm
IE=IB+IC;//mA
VBN=VBE+IE*Re;//V
V=VBN+IB*Rb;//V
R1=Rb*VCC/V;//kohm
IR1=(VCC-VBN)/R1;//mA
IR2=IR1-IB;//mA
R2=VBN/IR2;//kohm
disp(R1,"Value of R1(kohm)");
disp(R2,"Value of R2(kohm)");
format('v',5);
disp(Re,"Value of Re(kohm)");
disp(Rb,"Value of Rb(kohm)");
//Answer in the book is wrong.
```

Scilab code Exa 8.6 Determine Re and stability factor

```
//Ex_8_6
clc;
clear;
close;
format('v',6);
//given data :
VBE=0.7;//V
Beta=50;//unitless
VCE=4;//V
VCC=12;//V
Rc=4.3;//kohm
VEE=-6;//V
IC=1.5;//mA
S=3;//Stability factor(S<=3)
Rec=(VCC-VCE)/IC;//kohm(Rec=Re+Rc)
Re=Rec-Rc;//kohm
RbBYRe=(S-1)/(1-S/(1+Beta))
```

```
Rb=RbBYRe*Re;//kohm
IB=IC/Beta;//mA
V=IB*Rb+VBE+(IB/1000+IC)*Re;//V
R1=Rb*VCC/V;//kohm
R2=R1*V/(VCC-V);//kohm
disp(Re,"Value of Re(kohm)");
disp(R1,"Value of R1(kohm)");
disp(R2,"Value of R2(kohm)");
//Answer in the book is wrong for R1.
```